BRADBURNE
BRILLER &
JOHNSON, LLC

March 8, 2002

Mr. Bill Newberry
South Carolina Budget and Control Board
1201 Main Street - Suite 600
Capital Center - AFFINITY Building
Columbia, SC 29201-3227

RE: **Draft Report**
Evaluation of the Extended Care Fund
Barnwell LLRW Disposal Facility
Barnwell, South Carolina
BB&J Project No. 0053202

Dear Mr. Newberry:

Bradburne, Briller & Johnson, LLC is pleased to submit the State of South Carolina, Budget and Control Board this Draft Report associated with our Evaluation of the Extended Care Fund for the Barnwell Low-Level Radioactive Waste Disposal Facility. This report is being submitted pursuant to the project schedule agreed upon during the August 8, 2001 kick-off meeting and our discussions on November 16, 2001. If you have any questions or require additional information, please call.

Sincerely,

BRADBURNE, BRILLER & JOHNSON, LLC

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DRAFT REPORT

EVALUATION OF THE EXTENDED CARE FUND
BARNWELL LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY

Submitted to:

STATE OF SOUTH CAROLINA
BUDGET AND CONTROL BOARD
Columbia, South Carolina

Prepared by:

BRADBURNE, BRILLER & JOHNSON, LLC
Chicago, Illinois

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EXECUTIVE SUMMARY

Bradburne, Briller & Johnson, LLC (BB&J) was contracted to perform an evaluation of the adequacy of the Extended Care Fund for the Barnwell Low-Level Radioactive Waste (LLRW) disposal facility located in Barnwell, South Carolina (Barnwell facility).

The Barnwell facility is owned by the South Carolina Budget and Control Board and is operated under a lease agreement by Chem-Nuclear Systems, LLC (Chem-Nuclear). The Barnwell facility encompasses approximately 235 acres of land that is operated under South Carolina Department of Health and Environmental Control (DHEC) Radioactive Material License No. 097 (the License).

The overall objective of this project was to provide the State of South Carolina Budget and Control Board with recommendations on financial objectives and investment strategies so that anticipated, and potentially unanticipated, expenditures associated with the Barnwell facility's extended care period are adequately funded. In order to meet the project objective, financial data and information pertaining to the Barnwell facility's actual operations were evaluated. The review of facility-specific information was supplemented by evaluating the effect of potential operational scenarios on the Extended Care Fund, as well as attempting to glean insight from the practices of other states that have established trust funds for existing or planned LLRW disposal facilities.

Our principal findings are as follows:

- South Carolina's steps to not only ensure that funds are adequate, but to evaluate scenarios which could affect the Extended Care Fund balance and performance are measures apparently not undertaken by other states with similar LLRW disposal facilities. Consequently, it is our opinion that following review and consideration of the findings presented herein, the State of South Carolina will be better prepared and

should be more capable of anticipating and responding to potential situations, which may arise in long-term care.

- The conclusions of our financial analysis indicate that using: 1.) A $72.5 million beginning fund balance for the Extended Care Fund (as indicated by the State Treasurer as of July 1, 2002); 2.) The Chem-Nuclear cost estimates; and, 3.) A real rate of return of 2.0% over the next 140 years, the Extended Care Fund (Account E164693) balance would be depleted prior to the completion of activities under a private sector approach unless one or more of the following occur:

  - Costs are adjusted by the State;

  - The flow of funds to the account are increased; or,

  - Real interest rates are consistently above historical levels.

- In the document titled *Financial Data for Interim Site Stabilization and Closure Plan For the Barnwell Low-Level Radioactive Waste Disposal Facility 2000* dated September 2000, BB&J identified certain activities or items presented in Chem-Nuclear's cost worksheets which we feel should be reevaluated to address the projected shortfall in the Extended Care Fund under a private sector approach:

  - Laboratory Expenses;

  - Technician Labor; and,

  - Facility Performance Evaluations.

It is our opinion that there are various types of labor and expenses that could be managed differently or that certain unit rates and labor hours previously thought necessary to complete various tasks could be reevaluated (as described herein) such that the shortfall in the Extended Care Fund balance could be significantly reduced under a private sector approach.

- Using a beginning balance of $72.5 million, evaluation of other possible operational scenarios on the Extended Care Fund were evaluated by BB&J, which, including reasonable financial and technical assumptions described herein, would result in maintaining adequate funds in the account to cover all expenses during the 140-year period.

- If the State of South Carolina 1.) itself manages the facility rather than contracting the entire effort to a company in the private sector, 2). successfully implements the measures identified in this report to lower costs, and 3.) the Long-Term Care fund yields an average real rate of return of 2.0% for the 140-year period, it appears that the funds' estimated account balance of $72.5 million as of 7/1/02 is adequate to cover all expenses anticipated during the 140-year period.

1.0 INTRODUCTION

Bradburne, Briller & Johnson, LLC (BB&J) was contracted to perform an evaluation of the Adequacy of the Extended Care Fund for the Barnwell Low-Level Radioactive Waste (LLRW) disposal facility located in Barnwell, South Carolina (Barnwell facility).

The Barnwell facility is owned by the South Carolina Budget and Control Board and is operated under a lease agreement by Chem-Nuclear Systems, LLC (Chem-Nuclear). The Barnwell facility encompasses approximately 235 acres of land that is operated under South Carolina Department of Health and Environmental Control (DHEC) Radioactive Material License No. 097 (the License) as an LLRW disposal facility. The License was issued to the South Carolina Budget and Control Board (the Licensee).

2.0 BACKGROUND

This section presents background information pertinent to the Extended Care Fund evaluation. Specifically, Section 2.1 describes the regulatory framework governing operation and closure of LLRW facilities, such as the Barnwell facility. Section 2.2 presents waste disposal criteria applicable to the Barnwell facility. Section 2.3 presents facility-specific background information, including the closure requirements specified by the State of Carolina, as well as the current site schedule and associated funding sources.

2.1 Regulatory Background

Prior to 1954, nuclear energy activities were largely confined to the federal government. However, the passage of the Atomic Energy Act (AEA) in 1954 made it possible for private commercial firms to also engage in activities involving nuclear energy. The purpose of the AEA is to assure proper management of source, special nuclear and byproduct material. Due to the hazards associated with nuclear energy activities, Congress formed the Atomic Energy Commission (AEC) to, among other things, regulate commercial activities via licenses, but since

protection of the public health was traditionally a state responsibility, Section 274 was added to the AEA to provide a statutory basis for relinquishing federal authority to states. The mechanism for the transfer of AEC authority to a state is an agreement between the governor of the state and the AEC, which incorporates a finding by the AEC of the state's compatibility with federal radiation control programs. States entering into such an agreement are referred to as "Agreement States." South Carolina is one of 32 states that have been qualified as Nuclear Regulatory Commission (NRC) "agreement states." As an agreement state, South Carolina is required to regulate nuclear energy activities that are substantially equivalent to those set forth by the NRC.

The Energy Reorganization Act of 1974 replaced the AEC with the NRC, which became authorized to license nuclear reactors and storage facilities, and another agency, which later became the Department of Energy (DOE). In general, the AEA and these amended statutes delegate the control of nuclear energy to the DOE, the licensing of facilities to the NRC, and the management of non-radioactive components to the Environmental Protection Agency (EPA). Along with these agencies, the NRC routinely reviews state programs to assure that they effectively protect public health and safety from commercial nuclear activities.

Regulated activities include low-level waste disposal, high-level waste disposal and storage and transportation of spent nuclear fuel. The Office of Nuclear Material Safety and Safeguards has overall responsibility for NRC's radioactive waste regulation program and NRC's Regional Offices (Region I - Northeast, Region II - Southeast, Region III - Midwest, and Region IV - West/Southwest) implement these programs in the states for which they are responsible. Regulation of low-level waste disposal is regulated by both the NRC and Agreement States. Waste regulation is also supported by a Radioactive Waste Research program and by independent advice from the Advisory Committee on Nuclear Waste. The Low-level Radioactive Waste Policy Amendments Act of 1985 encouraged the states to enter into compacts that would allow them to dispose of waste at a common disposal facility. Most states have entered into compacts; however, no new commercial disposal facilities have been built since the Act was passed.

The NRC published as a Final Rule in the Federal Register (Vol. 47, No. 248. p. 57446) 10 CFR Part 61 *Licensing Requirements for Land Disposal of Radioactive Waste* on December 27, 1982 (10 CFR 61). Among other requirements, 10 CFR 61 provided for minimum requirements for financial protection of closure, post-closure, and for long-term care of sites following closure (i.e., the Institutional Control period). Additional clarification and guidance pertaining to financial protection, as prescribed by requirements of 10 CFR 61, can be found in the NRC's Technical Position paper titled *Funding Assurances for Closure, Post-Closure, and Long-Term Care of a Low-Level Waste Disposal Facility* issued in June of 1982. In its position paper, the NRC does not require that funding be set aside in an escrow account or trust fund to pay for long-term institutional control of a LLRW disposal facility. However, the NRC does point to such funds as a principal means that states might use to protect their interests. Where a facility, such as the Barnwell facility, is owned by the State of South Carolina and the lease makes clear that the state will assume ownership and responsibility for the Barnwell facility after closure, it is reasonable and prudent to set aside funds for the purpose of long-term care in a dedicated account so that the closed facility will not become a burden on taxpayers in the future. As indicated in Section 2.3.1, South Carolina, as a matter of state policy, requires that the operator of any LLRW disposal facility provide funding for long-term care and establish a means to ensure that the funds were adequate to defray all future costs of extended care.

2.2 Waste Disposal Criteria

According to 10 CFR 61, there are two general classes of criteria governing LLRW disposal: "prescriptive criteria" and "performance objectives." Prescriptive criteria set specific requirements on waste acceptance as well as site location, design, and operation. Performance objectives specify certain qualitative objectives that a disposal site must meet regardless of the specific general figures of merit for overall disposal site system performance. These are generally expressed in terms of allowed radiological dose to man based on a site specific Environmental Impact Statement. All disposal facilities licensed under 10 CFR 61 must meet the performance objectives, but could differ significantly in the way in which they are met. These criteria are discussed in detail in the following sections.

2.2.1 Prescriptive Criteria

The prescriptive criteria described in 10 CFR Part 61 under Subpart D falls into three major categories. These are site location, site design, and operation and waste acceptance.

Site Location Criteria – Site location criteria specifically focus on selecting a location, which will minimize any potential impact on man. These criteria include locations away from any areas prone to flooding, away from areas prone to tectonic activity, erosion, slumping, or landslides. Sites must also be selected with a ground-water table deep enough to preclude ground-water intrusion. Additionally, sites must be located away from population centers and developments.

Site Design Criteria – Site design and operation objectives include site markers, reducing the need for long-term maintenance, and establishing an environmental monitoring program which would be required after site closure.

Waste Acceptance Criteria – Waste acceptance criteria require that the waste form and packaging meet all applicable disposal stability, transportation, other disposal requirements established by the NRC and the Department of Transportation. Specifically:

- Wastes containing pyrophoric, biological, pathogenic, or infectious material must be treated to reduce the hazard to the maximum extent practicable;

- Waste liquids must be packaged in absorbent material to absorb twice the volume of the liquid; and,

- Containers for longer-lived wastes must maintain their structural integrity for a period of 300 years.

In addition, a second major requirement of the waste acceptance criteria is that all wastes be classified by their generators relative to their level of hazard. The classification system is based on the concentration of specific radionuclides in the waste and on the structural stability of the waste and its package. The classification system, which represents the NRC's scheme for achieving radioactive waste disposal safely and in a cost effective manner, is defined as follows:

- Class-A Stable Waste – low-activity waste that may be mixed with other types of waste.

- Class-A Unstable Waste – low-activity waste for which there are no stability requirements but require segregation from other wastes.

- Class-B Stable Waste – moderate activity waste which needs to be placed in a stable form and segregated from unstable waste.

- Class-C Waste – high–activity waste, which needs to be placed in a stable form, segregated from unstable waste, and disposed of in a manner, which will isolate it from being exposed by an inadvertent intruder for a reasonable period of time.

- Waste requiring special disposal evaluations – these wastes would generally not be suitable for near surface disposal, but may be acceptable on a case-by-case basis based on a detailed evaluation of the specific waste-form in conjunction with the specific site location, design, and operation criteria.

2.2.2 Performance Objectives

The performance objectives for land disposal of radioactive waste are specified in 10 CFR 61, which defines four categories for protection. These four categories are:

- Protection of the general population (61.41);
- Protection against inadvertent intrusion (64.42);
- Protection of individuals during operations (61.43); and,
- Stability after site closure (61.44).

Performance objectives include the maximum allowable dose levels for both the general population and for an individual who might inadvertently disturb a LLRW burial site after the facility has ceased operations. The waste acceptance criteria described in Section 2.2.1 contribute to intruder protection by requiring that all potentially harmful waste streams be "stabilized."

Protection of the general population and the impact of the Barnwell disposal facility are evaluated through the Performance Assessment. A Performance Assessment is periodically conducted which re-evaluates the site as operations continue and includes mathematical modeling of radionuclide migration as a function of specific site characteristics. Examples of factors considered in a Performance Assessment include:

- Container lifetime;
- Retardation factor of nuclide;
- Vertical travel time from trench bottom to aquifer;
- Distance to well from down-gradient edge of burial site;
- Aquifer velocity;

- Distance across burial site in the direction of aquifer flow;
- Waste-form leach rate;
- Annual precipitation;
- Trench mixing dynamics; and,
- Burial site area and volume.

These factors are necessary inputs for models required to evaluate performance objectives. The monitoring and maintenance activities ensure the system of barriers established to isolate the waste from man and the biosphere during site operations continue to be effective throughout the one hundred years of institutional control. Performance Objectives are discussed further in Section 4.2.1.

2.3 Site-Specific Background Information

This section presents site-specific background information, including site history and the current schedule for site activities and associated funding sources.

2.3.1 Site History

The Barnwell facility was the last of six commercially operated shallow-land radioactive waste disposal facilities to begin operation in the United States. South Carolina became an Agreement State in 1969. The License was initially issued to the Licensee by DHEC on November 6, 1969 to allow the storage of radioactive material, and was amended April 13, 1971 to allow disposal of radioactive material by shallow land burial. Disposal of radioactive waste, including Class A, B, and C wastes, by shallow land burial has continued to this time. The DHEC formally began

planning for burial site closure and stabilization with the issuance of Amendment 24 to the License on May 16, 1979, which required the Licensee to prepare a preliminary plan that:

- Describes the eventual transition of site usage from active disposal operations to passive maintenance;

- Proposes site closure and stabilization strategies that are consistent with the NRC Waste Branch Position titled Low Level Waste Burial Ground Site Closure and Stabilization dated April 10, 1979; and,

- Accounts for financial assurance for the actions described in the preliminary plan.

The State of South Carolina implemented the requirement for financial assurance for long-term care through the use of two legal instruments: a Decommissioning Trust Fund and a Lease Agreement made between the State of South Carolina and Chem-Nuclear which established an Extended Care Maintenance Fund (Extended Care Fund). This approach was designed to ensure that the Licensee and the waste generators who use the Barnwell facility, not the State's taxpayers, would assume financial responsibility for closure and long-term care of the site.

Consequently, the Decommissioning Trust Fund was established pursuant to a Trust Agreement dated March 4, 1981, among Chem-Nuclear (grantor), the State of South Carolina Budget and Control Board (beneficiary), and the South Carolina State Treasurer (trustee), whose purpose is to assure adequate funding for the decommissioning of the disposal site, or any successor fund with a similar purpose.

The Extended Care Fund is a state account that will be used for the custodial, surveillance, and maintenance costs during the Institutional Control period and any Post-Closure observation period specified by DHEC. The custodian of the Extended Care Fund is the South Carolina Budget and Control Board. The current authority of the Budget and Control Board, including

duties and responsibilities is provided by Section 13-7-30, South Carolina Code of Laws. This section provides that:

> *"The authority to collect fees from private or public parties holding radioactive materials for custodial purposes. The fees are required to be sufficient for the extended care custodial management activities, and additionally, provide for insurance to protect the general public in the event of migration or dispersal of any radioactivity."*

This provision of the South Carolina Code was amended by Act 357 (2000) to provide:

> "*The extended care maintenance fund must be used exclusively for custodial, surveillance, and maintenance costs during the period of institutional control and during any Post-Closure and observation period specified by the Department of Health and Environmental Control, and for activities associated with closure of the site. Funds for the extended care maintenance fund shall not be used for site closure activities or for custodial, surveillance, and maintenance performed during Post-Closure observation period until all funds in the decommissioning trust account are exhausted.*"

Chem-Nuclear, as the site operator, is required by the Condition 98 of the License to submit a site closure plan. Specifically,

> *"An interim site closure and stabilization plan, assessment of current operating practices, and the long-term care plan for the site shall be submitted for review one year prior to the expiration date listed in Condition 4 of this license. The plan shall be consistent with Condition 97 of this license and shall include demonstration that funds are being set aside or other measures being taken are adequate to finance site closure and long-term care. The plan shall also include preliminary estimates of costs, environmental impacts, data needs, personnel needs, material and equipment needs, planned documentation and quality assurance, and detailed plan for trench locations and elevations, expected capacities, planned surface contours, and buffer zones"*.

2.3.2 Current Schedule for Site Activities and Associated Funding Sources

The Barnwell site will transition through four phases relative to the active lifespan of the disposal facility as follows:

- Current Operational Period – During this period, Barnwell will receive LLRW at disposal volumes, which are limited by South Carolina law, from fiscal year (FY) 2000/2001 to FY 2007/2008. Several activities are scheduled to occur during this period in preparation for the Phase I Closure portion of the In-Region Operational Period.

- In-Region Operational Period – This period is defined as the thirty years of operation during which only Atlantic Compact (Connecticut, New Jersey, and South Carolina) waste is received at the disposal facility, and is estimated to extend until FY 2037/2038. During the in-region operations period, the first two years will include Phase I Closure activities, which will close the majority of the facility, leaving only those trench areas designated to receive the Atlantic Compact LLRW. Finally, the Phase I Post-Closure Observation Period will be conducted from FY 2010/2011 through FY 2014/2015 following the Phase I Closure.

- Phase II Closure and Post-Closure Observation – After completing the last year of the In-Region Operational Period, the site will undergo Phase II Closure, which consists of closure of the final active disposal area. Phase II Closure is currently scheduled for FY 2038/2039. The Phase II Post-Closure Observation Period will follow, which is scheduled to begin in FY 2039/2040 continuing through FY 2043/2044.

- Institutional Control Period – The Institutional Control Period will be conducted for a 100-year period following the end of the Phase II Post-Closure Observation Period, and is expected to be completed by FY 2143/2144. Following Phase II Post-Closure Observation, the Barnwell facility will complete transition to direct State control.

Activities during the Institutional Control Period consist of grounds maintenance and environmental monitoring. The Institutional Control Period is described in greater detail in Section 4.3.1.

According to Chem-Nuclear's *Financial Data for Interim Site Stabilization and Closure Plan For the Barnwell Low-Level Radioactive Waste Disposal Facility 2000* dated September 2000 (Closure Plan), expenditures from the Extended Care Fund have been assumed to begin concurrently with the In-Region Operational Period through the Institutional Control Period, a period of time referred to herein as the extended care period. The Closure Plan is currently under review by DHEC as part of the License renewal process.

Funding for current and future site activities is provided by the three sources described below:

- An on-going assessment on waste receipts during the current operational period and the in-region operations period.

- The Decommissioning Trust Fund, which is dedicated for site closure activities scheduled through Phase I Closure.

- The Extended Care Fund, which accounts for costs associated with the Institutional Control Period, as well as those activities not covered by waste receipts collected during In-Region Operations or after Phase I Closure.

3.0 OBJECTIVE

The overall objective of this project was to provide the State of South Carolina Budget and Control Board with recommendations on financial objectives and investment strategies so that anticipated, and potentially unanticipated, expenditures associated with the Barnwell facility's extended care period are appropriately funded. Consequently, while other funds associated with

the Barnwell facility are referenced herein, only the adequacy of the Extended Care Fund was evaluated.

In order to meet the project objective, financial data and information pertaining to the Barnwell facility's actual operations were evaluated. The review of facility-specific information was supplemented by evaluating the effect of potential operational scenarios on the Extended Care Fund, as well as attempting to glean insight from the practices of other states that have established trust funds for existing or planned LLRW disposal facilities.

Since the scope of this evaluation is on the Extended Care Fund, it is important that all the planned activities are identified, along with an estimate of cost and frequency of occurrence. This report specifically provides a review of the extended care period portion of the Closure Plan.

4.0 TECHNICAL CONSIDERATIONS

The following sections summarize our findings with respect to Technical Considerations, which are categorized as those plans, operations, objectives and costs that pertain solely to the operation of a LLRW disposal facility and that were reviewed in support of achieving this project's objective. Financial Considerations of the project are discussed in Section 5.0.

4.1 Extended Care Plans - Comparative Analysis

BB&J reviewed and compared available records such as closure plans, extended care plans, and institutional care plans available via the Freedom of Information Act (FOIA) for states where LLRW disposal sites are, have been, or are proposed to be operated. The objective of the comparative analysis was to assess the status of the Barnwell facility relative to other facilities with respect to extended care planning and securing financing needed for future management of the facility during the extended care period. Because facilities operated for the disposal of DOE

waste are generally not required to have financial assurance plans for post-closure care, only commercially operated sites were selected for this comparison.

BB&J reviewed information about eight commercially operated shallow-land disposal facilities that have been proposed or licensed and operated in the United States and where reasonable information about the facilities was available for comparison to the Barnwell facility (For example, some proposed facilities that were not licensed to operate were not reviewed by BB&J):

- Sheffield, Illinois;
- Maxey Flats, Kentucky;
- Boyd County, Nebraska;
- Beatty, Nevada;
- West Valley New York;
- Sierra Blanca Texas;
- Tooele County, Utah;
- Richland, Washington; and,
- Barnwell, South Carolina.

Four of these sites (Nevada, Kentucky, New York and South Carolina) were licensed by State regulatory agencies under agreements with the NRC. Washington and Illinois were licensed by the NRC because the states had not yet become agreement states. Three of the sites have been

closed for over 20 years. The sites in West Valley, New York and Maxey Flats, Kentucky were closed in 1975 and 1977 respectively, because of water management problems. In 1978, the Sheffield, Illinois site was closed after the operator experienced lengthy delays with its NRC license renewal. The Beatty, Nevada site closed at the end of 1992 in accordance with an agreement between the Governor of Nevada and the Rocky Mountain Compact Board. Boyd County, Nebraska was denied a permit and was never built. The Texas LLRW Disposal Authority filed an application with the Texas Natural Resource Conservation Commission to construct, operate and close a commercial LLRW disposal facility near Sierra Blanca, Texas. The application was denied. The other three disposal facilities, located in Tooele County, Utah; Richland, Washington; and Barnwell, South Carolina, continue to receive and dispose of LLRW.

The status of each of the sites other than the Barnwell facility is discussed in Appendix A. A Comparative Analysis Summary is provided below.

4.1.1 Comparative Analysis Summary

Four states, Illinois, Nevada, Washington and South Carolina, have existing institutional care funds to ensure that monies are available for the long-term maintenance and monitoring of their LLRW disposal facilities.

As part of the promulgation of 10 CFR 61, a Draft Environmental Impact Statement (DEIS) was developed and issued as Nuclear Regulatory Commission document (NUREG)-0782 in September of 1981. This DEIS delineated four geographic regions within the United States (Southeast, Northeast, Midwest, and Southwest). Within each region, a hypothetical disposal facility was assumed to be located at a site representing the generic environmental characteristics of that region. While the four regional site characteristics varied greatly, the Southeast region was determined to be the most limiting due to the relatively high rate of percolation and relatively short distance to the nearest public water sources. Providing a point-by-point comparison of the institutional care programs and fund management strategies to South Carolina is difficult given the different regions of the country in which they are located and given the

probability that each facility had their own unique disposal practices. It is clear, however, that by establishing an extended care trust fund while still in operation, South Carolina will benefit – as opposed to Illinois, which established the institutional care fund for the Sheffield facility after it was closed.

Statements regarding the adequacy of funds for the various facilities reviewed, including the Barnwell facility, (e.g., the Closure Plan and the adequacy of the Extended Care Fund), have been noted. However, we were unable to locate any similar fund analysis reports for the facilities evaluated herein. South Carolina's steps to not only ensure that funds are adequate, but to evaluate scenarios which could affect fund balance and performance, is a task that has apparently not been undertaken by other States.

4.1.2 Previous Barnwell Closure Dates

Another point of comparison with which to evaluate the adequacy of the extended care fund today are the fund balances on previous statutory dates for closure of the Barnwell facility. Under South Carolina laws that have since been repealed, the Barnwell facility was slated for closure on January 1, 1992 and to be replaced by a planned facility in North Carolina. The planned closure date was later revised to occur on January 1, 1995 before it was eventually revised to its current planned date.

As indicated in Table 1, the balance of the extended care fund at the beginning of fiscal year 1992 (July 1, 1991) was $49,652,000. The balance at the beginning of fiscal year 1995 (July 1, 1994) was $64,083,000.

Detailed review of the plans for extended care that were developed in conjunction with those planned closure dates was beyond the scope of this report. However, we assume that they entailed activities similar in nature to the current extended care plan, and that funding was deemed sufficient to cover the costs of those activities.

4.2 Cost Scenarios - Extended Care

In order to meet the project objective, financial data and information pertaining to Barnwell's actual facility operations were evaluated as well as cost projections and plans provided by Chem-Nuclear as required by the License.

The review of facility-specific information was supplemented by evaluating the effect of potential operational scenarios on the Extended Care Fund. Six cost scenarios were chosen to represent a broad range of possibilities with which to assess funding adequacy. These cost scenarios were developed as modifications to the "Base Case" scenario costs presented in the Closure Plan (Scenario 1). Chem-Nuclear's projections and the activities on which they are based were reviewed. The activities were found to be consistent with the current performance objectives required by the License with the cost estimates associated with those activities based on actual costs of similar activities to date. Additionally, the activities included in the Closure Plan are consistent with the current proposed plans for the site through transition into long-term stewardship. For these reasons, the Chem-Nuclear 2000 Closure Plan was chosen as the best starting point from which to base the scenarios provided.

To justify the potential for any of the scenarios, sections 4.2.2 through 4.2.4 discuss:

- The merits of public vs. private sector approaches;
- The potential for reduced monitoring and maintenance activities;
- The potential need for remedial measures.

The resulting cost scenarios include:

- Scenario 1 – The "Base Case" scenario featuring a Public Sector Approach with a Stepwise Reduction in Monitoring and Maintenance Levels during the institutional control period;

- Scenario 2 – Public Sector Approach with Monitoring and Maintenance Levels Remaining Constant and No Remedial Action;

- Scenario 3 – Public Sector Approach with a Stepwise Reduction in Monitoring and Maintenance Levels during the institutional control period and including a Remedial Action;

- Scenario 4 – Private Sector Approach with a Stepwise Reduction in Monitoring and Maintenance Levels during the institutional control period;

- Scenario 5 – Private Sector Approach with Monitoring and Maintenance Levels Remaining Constant and No Remedial Action; and,

- Scenario 6 – Private Sector Approach with a Stepwise Reduction in Monitoring and Maintenance Levels during the institutional control period and including a Remedial Action.

These scenario descriptions are also presented in Table 2 to facilitate convenient referencing throughout the document.

The primary deviation from the Chem-Nuclear approach was to account for periodic costs as an expense in the year in which they were predicted to occur rather than annualizing them. Other subtleties are identified as notes on the appropriate spreadsheet table. Additionally, it should be noted that the analysis presented in the following scenarios include the following assumptions:

- Revenues from waste disposal operations will remain sufficient to cover the site operator's allowable costs, including the operating margin (deficit may be offset from the Extended Care Fund); and,

- Revenues will remain sufficient to reimburse the Budget and Control Board, the Public Service Commission (PSC), and the State Treasurer under Section 48-46-60(B), including the Compact Commission under Section 48-46-60(C) (deficit may be offset from the Extended Care Fund).

Either of the above conditions, if they did not exist, could significantly impact the distribution of monies from the fund in the affected year, or years in which the condition would occur. In addition, the outcome of the scenarios could be significantly affected by several contingencies and variables including the rate of return.

4.2.1 Basis of Extended Care Costs

The costs associated with extended care period are a continuation of selected activities, which ensure that the site would continue to meet performance requirements long after closure. These selected activities, items a through p, are described below.

To provide a thorough evaluation of the cost elements of the Extended Care Fund, the current performance objectives were reviewed, and for each activity, which satisfies an objective, the source of funding was identified. The four phases of the life cycle of the Barnwell facility are not distinct, but are overlapping, as is the source of funding for activities that take place in each phase. Rather than waiting until the Barnwell facility is entirely closed and no longer accepting waste, DHEC decided that it would be more protective to initiate some closure activities in advance of the complete cessation of disposal operations. Permanent capping of disposal trenches began in 1991 and is currently on-going. Approximately 80 percent of burial trenches now have permanent site caps. Funding for this activity comes from the Decommissioning Trust Fund.

When the In-Region Phase begins after fiscal year 2008, all remaining disposal operations will take place in a small area in the southeast corner of the Barnwell facility. The remaining portions of the Barnwell facility will essentially be closed and permanently capped, except for dismantlement of the remaining operations buildings and closure of the few final trenches used for Atlantic Compact waste. Because of this, Chem-Nuclear has proposed in the Chem-Nuclear 2000 Closure Plan that funding for the monitoring of the Barnwell facility after 2008 will be paid from the extended care fund. If Chem-Nuclear's proposal is approved, it will eliminate the need to pass monitoring costs for the Barnwell facility along to the Atlantic Compact generators. Therefore, it is assumed in this report that the costs of the monitoring program beginning after the year 2008 are paid for from the extended care fund.

The site performance objectives required by DHEC and the License issued August 11, 1995 consist of the following:

> Condition 97 - The Licensee shall develop a site closure and stabilization plan that addresses, as a minimum, the following performance objectives:
>
> a. Bury all waste in accordance with the requirements of the license.
>
> DHEC has assigned a state official to the facility on a full-time basis to inspect incoming shipments and to assure proper burial operations in accordance with the License. Chem-Nuclear has also established procedures, trained personnel in their use, and assigned specific individuals responsible for ensuring Chem-Nuclear compliance. Additionally, Chem-Nuclear maintains an internal audit program to periodically self-assess compliance with licensing requirements.
>
> The costs associated with these activities are allowable costs reimbursed from gross revenues generated from waste disposal receipts.

Task	**Funding Source**
Waste Disposal Operating Costs	Waste Receipts

b. Dismantle, decontaminate, as required, and dispose of all structures, equipment, and materials that are not to be transferred to the site custodian.

Current plans are for all the structures currently within the restricted area to be dismantled and disposed on site. The sequence of dismantling and disposal identifies the Site Operations and Maintenance Building, the Cask Preservation Building and the Field Services Warehouse to be dismantled and disposed of during Phase I Closure activities and funded out of the Decommissioning Trust Fund.

The Receiving Warehouse No. 2, Site Building, HP Building, Cask Maintenance Building, Grounds Maintenance Shop, Drilling Equipment Storage Trailer and the Instrument Calibration Shop are scheduled to remain through In-Region Operations. Costs associated with the upkeep of these facilities during the In-Region Operations period appear budgeted as costs covered by the Extended Care Fund. The cost associated with demolition and disposal of these facilities as a function of Phase II Closure is currently planned to be funded by the Extended Care Fund.

Task	**Funding Source**
Phase I Closure Decommissioning and Demolishing (D&D)	Decommissioning Fund
Phase II Closure D&D	Extended Care Fund
Facility Maintenance	Extended Care Fund

c. Document the arrangements, and the status of the arrangements, for orderly transfer of site control and for long- term care by the government custodian. Also, document the agreement, if any, of state or federal governments to participate in, or accomplish,

any performance objective. Specific funding arrangements to assure the availability of funds to complete the site closure and stabilization plan must be made.

The State of South Carolina owns the property Chem-Nuclear uses for the disposal of LLRW. The current arrangement for orderly transfer is primarily identified as tasks under Phase I Closure followed by Phase I Post-Closure Observation. This is followed by the Phase II Closure tasks and a Phase II Post-Closure Observation period. Tasks associated with Phase I Post-Closure are funded through the Decommissioning Fund. Phase I Post-Closure Observation and both Phase II Closure and Post-Closure Observation activities are funded from the Extended Care Fund.

Task	**Funding Source**
Phase I Post-Closure	Decommissioning Fund
Phase I Post-Closure Observation	Extended Care Fund
Phase II Closure and Post-Closure Observation	Extended Care Fund

d. Direct gamma radiation from buried wastes should be essentially background.

Direct gamma radiation surveys are required to be taken as a function of normal operations and when trenches are closed. The requirement for readings to be background has been previously established. Direct gamma radiation surveys, as part of disposal operations should be budgeted as a normal operations expense, funded through waste receipts. A comprehensive final site survey will be performed, which includes a survey to evaluate direct gamma radiation, is planned at completion of Phase I Closure and again at the end of Phase II Closure. The costs for Phase I Closure surveys are covered by the Decommissioning Trust Fund. Phase II Closure surveys will be funded by the Extended Care Fund.

Task	**Funding Source**
Phase I Closure Site Radiation Surveys	Decommissioning Fund
Phase II Closure Site Radiation Surveys	Extended Care Fund

e. Demonstrate by measurement and/or model during operations, and after site closure, that concentrations of radioactive material which may be related to the general environment in ground water, surface water, air, soil, plants, or animals will not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any organ of any member of the public.

The current plan to demonstrate this objective is through the use of a comprehensive site Performance Assessment. A Performance Assessment will take place after Post-Closure activities and is currently planned for the Phase I and II Post-Closure Observation Periods. This involves utilizing the Chem-Nuclear environmental monitoring data to model dose rates to members of the public. Utilizing the latest ground-water level and stream flow maps to calibrate the ground-water model and then using the ground-water model, ground-water path lines will be calculated to compare projected tritium and carbon-14 concentrations with actual data. This validates the site modeling capability and provides confidence on model projections. Air pathway dose assessments are not currently planned due to the negligible environmental monitoring data. The Performance Assessments are currently planned to be performed at 25-, 50- and 100-year intervals.

Task	**Funding Source**
Phase I Closure Performance Objectives Assessment	Decommissioning Fund
Phase II Closure Performance Objectives Assessment	Extended Care Fund

f. Render the site suitable for surface activities during custodial care. Planned custodial care may be limited to activities such as vegetation control, minor maintenance, and environmental monitoring. However, use of the site surface for activities such as

parking lots may be planned. Final conditions at the site must be acceptable to the government custodian and compatible with its plan for the site.

No long-term plan for the site has been identified other than a LLRW disposal facility. The final slope, grades, and surface water management plan are scheduled as part of Phase I Closure Activities and Phase II Closure Activities. The final site condition will provide for this requirement. The final site topography will include an activity identified as Site Final Grading and Contouring.

Task	**Funding Source**
Phase I Closure Site Grading and Contouring	Decommissioning Fund
Phase II Site Final Grading and Contouring	Extended Care Fund

g. Demonstrate that all trench elevations are above the water table levels taking into account the complete history of seasonable fluctuations.

Chem-Nuclear maintains a network of monitoring wells, both on and off-site. On-site wells monitor ground water near trench locations and at the site boundaries. Off-site wells are located both up and down gradient of the site. This monitoring is part of the collective site-monitoring program and will be funded by the Extended Care Fund starting with the Phase I Post-Closure Observation Period.

Task	**Funding Source**
Site Monitoring Program (starting with Phase I Post-Closure)	Extended Care Fund

h. Eliminate the potential for loss of site or trench integrity due to factors such as erosion, surface water, wind subsidence, and frost action. For example, an overall

site surface water management system must be established for humid sites to drain rainwater and snowmelt away from burial trenches. All slopes must be sufficiently gentle to prevent slumping or gullying. The surface must be stabilized with established short rooted grass, rock, riprap, or other measures. Trench caps must be stabilized to minimize erosion, settling, or slumping of caps.

There are significant activities as a function of Phase I Closure where enhanced caps are constructed over the completed portion of the burial site, additionally during Phase I Closure, the West Storm Water Retention Basin activity is planned. During Phase II Closure, the remaining trenches receive the enhanced capping, and the South Storm Water Retention Basin activity is planned.

Task	**Funding Source**
Phase I Closure Enhanced Capping	Decommissioning Fund
West Storm Water Basin	Decommissioning Fund
Phase II Closure Enhanced Capping	Extended Care Fund
South Storm Water Basin	Extended Care Fund

i. Demonstrate that trench markers are in place, stable, and keyed to benchmarks. Identifying information must be clearly and permanently marked.

There is currently a grid system on site for horizontal control of site features and trench location. Permanent benchmarks are established for surveying across site. Trench corner markers are located with a marker with specified information inscribed. As trenches are closed during Phase I Closure, these costs are funded from the Decommissioning Trust Fund. During Phase II Closure, these costs are covered by the Extended Care Fund. Periodic surveys are performed to assess site contours. These periodic surveys costs are funded by the Extended Care Fund after Phase I Closure.

Task	**Funding Source**
Phase I Closure Permanent Trench Markers	Decommissioning Fund
Phase I Closure Land Surveys	Decommissioning Fund
Phase II Closure Permanent Trench Markers	Extended Care Fund
Post Phase I Closure Land Surveys	Extended Care Fund

j. Compile and transfer to the DHEC complete records of site maintenance and stabilization activities, trench elevation and locations, trench inventories, and monitoring data for use during custodial care for unexpected corrective measures and date interpretation.

The site has an established protocol in which site monitoring data is currently transmitted to DHEC on monthly and quarterly bases. Both Chem-Nuclear and DHEC share trench drawings and construction information throughout the each phase of design, construction, and closure. This process and the information transmitted is a normal part of disposal site operations and as such is funded by waste receipts during the Current Operational Period and during In-Region Operations.

As part of Phase I Closure, a Records Transfer will occur during which Chem-Nuclear will identify, transfer, and provide storage for certain Barnwell site records for Post-Closure use by the State of South Carolina. Records would be transferred following the completion of Phase I Closure. This effort will be funded by the Decommissioning Trust Fund.

Task	**Funding Source**
Routine monitoring and trench design and construction data	Waste receipts
Records transfer during Phase I Closure	Decommissioning Fund
Records transfer during Phase II Closure	Extended Care Fund

k. Establish a buffer zone surrounding the site sufficient to provide space to stabilize slopes, incorporate surface water management features, assure that future excavation on adjoining areas would not compromise trench or site integrity, and provide working space for unexpected mitigating measures in the future. The buffer zone must also be transferred to the custodial agency. The buffer zone may generally be less than 300 feet but not less than 100 feet.

A 100-foot buffer zone is currently established within the current licensed disposal area boundary. There is a high probability that property boundaries and designations will be changed to reflect the best configuration for long-term management and monitoring of the disposal facility. With this adjustment, a task to relocate the fence and property boundary is planned to occur as part of Phase II Closure. This task will be funded by the Extended Care Fund.

Task	**Funding Source**
Fence and Boundary Relocation	Extended Care Fund

l. Provide a secure passive site security system (e.g., a fence) that requires minimum maintenance.

The site has currently provided a seven-foot high fence with three strands of barbed wire. The fence is galvanized steel mesh, with galvanized steel posts set in circular concrete anchor footings. Periodic maintenance is anticipated on the fence with costs funded by the Extended Care Fund after Phase I Closure.

Task	**Funding Source**
Fence Upkeep and Maintenance Post Phase I Closure	Extended Care Fund

m. Stabilize the site in a manner to minimize environmental monitoring requirements for the long-term custodial care phase and develop a monitoring program based on the stabilization plan.

The proposed environmental monitoring program is being developed based on the site's expected performance and with emphasis on ground-water monitoring, since it has been determined to be the primary release pathway for the Barnwell facility. There is currently a program of monitoring well abandonment in place with the majority of completion expected at the end of Phase I Closure.

Task	**Funding Source**
Well Abandonment	Decommissioning Fund

n. Investigate the causes of any statistical increases in environmental samples, which have occurred during operation and stabilization. In particular, any evidence of unusual or unexpected rates or levels of radionuclide or hazardous constituent migration in or with the ground water must be analyzed and corrective measures implemented.

There currently exists reporting protocol between Chem-Nuclear and DHEC when environmental data indicate a change in site radiological conditions. Previously the detection of tritium and carbon-14 plumes resulted in enhancements to trench capping. These activities and funding sources were identified in conjunction with Performance Objective h.

Task	**Funding Source**
Phase I Closure Enhanced Capping	Decommissioning Fund
Phase II Closure Enhanced Capping	Extended Care Fund

o. Eliminate the need for active water management measures such as sump or trench pumping and treatment of the water to assure that wastes are not leached by standing water in the trenches.

This performance objective will be satisfied by the final grading and vegetation of the site, including the enhanced capping of completed trenches. These activities and funding sources were identified in conjunction with Performance Objective f, h, and n.

Task	**Funding Source**
Site Final Grading and Contouring	Decommissioning Fund
Phase I Closure Enhanced Capping	Decommissioning Fund
Phase II Closure Enhanced Capping	Extended Care Fund

p. Evaluate present and zoned activities on adjoining areas to determine their impact on the long-term performance of the site and take reasonable action to minimize the effects.

Chem-Nuclear works with the Barnwell County development board. This activity is considered a function of corporate support. Current cost estimates include an activity for corporate support which would be funded from the Extended Care Fund after Phase I Closure.

Task	**Funding Source**
Corporate support as a part time function, post Phase I Closure	Extended Care Fund

4.2.2 Public vs. Private Sector Approach

This section discusses advantages and disadvantages to public versus a private sector performance of some, or all, aspects of the maintenance and monitoring activities associated with the Institutional Control period.

The private sector approach to managing the Barnwell facility is one with which the State of South Carolina is probably the most familiar. The relationship between DHEC and the operator, Chem-Nuclear has, based on site performance, been a very good one. The advantage of a private contractor managing the day-to-day maintenance and monitoring of the site is that they typically are able to respond and adapt to changing conditions and requirements much faster than a public entity. Since they are also for-profit, incentive for good performance, and conversely, leverage against poor performance, may be applied. However, since they are for-profit, a reasonable fee is expected which tends to make them more expensive than that of a public organization.

The public sector on the other hand provides more opportunities for continuity of operations. Where private organizations may come and go based on profitability, duration of contracts, change of ownership, or other reasons, public organizations tend to be much more stable. The duration of the Institutional Control period is one hundred years, so public sector management of this period may be more effective.

There is the potential that some combination of both may be to the State of South Carolina's advantage. The monitoring program, which is required throughout the Institutional Control period, could certainly be performed as part of a university research program. This approach could also bring with it additional sources of funding as well. Routine maintenance of the grounds may also be suitable for public sector management. The types of activities normally encountered would tend to fall within routine level of effort tasks such as mowing, maintaining right-of-ways, etc. Short duration activities with a specific scope of work lend themselves to be subcontracted to the private sector. These activities would probably be remedial actions such as geo-textile fabric repair, specific construction activities, or a pump and treat scenario.

Since long-term care activities lend themselves to routine level of effort activities, a public sector approach was chosen as the base case scenario.

4.2.3 Reduction in Monitoring and Maintenance due to Ramped-Down Activities

Several of the activities associated with active maintenance and monitoring of the disposal facility during the Institutional Control period will likely be ramped-down over time.

Chem-Nuclear maintains an extensive environmental monitoring program for the Barnwell disposal facility. The monitoring system is designed to fulfill several functions. The primary objective is to detect any releases of radioactivity from the site during operations and after closure. This information can be used to estimate potential doses to off-site individuals and serves to demonstrate compliance with regulatory requirements. The monitoring system additionally provides an early warning of unusual or unforeseen conditions which may require remediation.

The radiological monitoring program at the Barnwell facility involves sampling of the atmosphere, soil, vegetation, surface water, sediment, and ground water. Direct radiation from the site is also monitored.

As described in previous sections, while the site undergoes Phase I and Phase II Closure, Performance Assessments will be performed as part of the Post-Closure Observation periods. The comprehensive assessments performed during these phases should serve to validate site characteristics. Based on historical monitoring results, site characteristics should vary within a sufficiently narrow range so that the input to modeling is representative of the hydrogeologic units and the assumptions underlying the modeling are valid. Additionally, the site should stabilize to the point that natural processes affecting the disposal site should be occurring at a consistent and definable rate such that the modeling of the site will represent both present and anticipated site conditions. It is anticipated that the site characteristics will be such that a reasonable number of monitoring points can adequately describe the extent to which radionuclides have migrated from waste disposal units. Finally, based on the relatively short half-lives of CO-60, the predominant radionuclide, and H-3, the predominant mobile

radionuclide, which are 5.5 years and 12 years, respectively, the potential for release of radionuclides diminishes significantly within a few decades.

Stability will also play an important role in reducing maintenance activities required at the facility. Class B and C wastes should maintain their gross physical properties to provide for site stability and the incidence of erosion and trench maintenance should decrease over time. As Class A disposal trenches mature and the waste has time to decay, protection relies on the more passive considerations of site design and waste form.

With these considerations in mind, the most probable scenario would be to expect costs to decrease over time with respect to monitoring, surveillance and maintenance activities.

4.2.4 Potential Remedial Measures

Chem-Nuclear first initiated waste disposal in 1971. Prior to the early 1980s, the long-term performance of LLRW disposal sites was governed solely by site design and by local geological and hydrologic conditions. Waste packaging used during this time was intended primarily to allow safe handling and meet the requirements for transportation, rather than serve as a long-term (i.e., 300 years or more, as described in Section 2.2.1) containment vessel. This meant that neither the waste form, nor its container, was a significant consideration for long-term LLRW disposal safety and that waste only received treatment as required to meet transportation regulations. Consequently, because Barnwell accepted waste for nine years prior to improvements in waste form and other requirements under 10 CFR 61, the need for site remediation in the future cannot be ruled out.

The buffer zone around the perimeter of the site is considered three dimensional, with the most likely pathway for radionuclide migration at the Barnwell facility being ground water. From routine environmental monitoring and Environmental Radiation Performance Verification (ERPV) measurements, Chem-Nuclear has identified tritium and carbon-14 as the only radionuclides measured outside of disposal trenches and migrating in the ground water. The

most recent ERPV report, BEDL-00-010, *Environmental Radiation Performance Verification of the Barnwell Waste Disposal Facility Summary*, dated June 19, 2000 concluded the actual dose from radionuclides leaving the Chem-Nuclear property boundary is zero because there are no known consumers of surface water downgradient of the property. From beneath the trench area, ground water flows to the southeast to a seepage point at Mary's Branch. Ground water flows from the Barnwell facility under AGNS property and under the Savannah River site. Therefore, access by the general public to or general uses of ground water that might have been contaminated by releases from the Barnwell facility is unlikely to occur. In addition, the concentrations of radionuclides that may reach Mary's Branch are expected to remain within regulatory standards. As a result, the Barnwell facility has experienced very good site performance as verified by the environmental monitoring program.

Because the most likely pathway for radionuclide migration is the ground-water pathway, it is appropriate to consider a pump and treat scenario as the most probable remedial action. However, given the chain of barriers established for disposal site safety and the past performance of the disposal facility, the probability of radionuclide migration in sufficient concentrations, which would require a pump and treat scenario is considered low. For this reason, funding for remedial action is not factored into the base case, but is considered in several of the alternative scenarios.

4.3 Other Extended Care Cost Scenarios

The following sections address other scenarios, including variations in the duration of the Institutional Control Period and the possibility of suspended operation, that were not included in extended care cost scenarios because they would drastically change the effectiveness of the Extended Care Fund. Also included is a section addressing the applicability of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), which would drastically change the scope of the Extended Care Fund.

4.3.1 Institutional Control Duration

Via 10 CFR 61, the NRC established a 100-year minimum institutional control period because it is anticipated that Class A-type radioactive wastes would decay to innocuous levels within that time frame. However, because Class B and C wastes would still be hazardous after the 100-year period, 10 CFR 61 requires that these wastes should:

- Maintain their gross physical properties;
- Maintain their identity for 300 years to provide for site stability; and,
- Be protected from land use scenarios where the subsurface is likely to be disturbed, such as construction and agriculture activities.

Consequently, at the Barnwell facility, during the 100-year Institutional Control Period the site will be actively monitored until Class A wastes have the opportunity to undergo sufficient decay, after which time, restrictions on land use will be required for potentially several hundred years beyond the Institutional Control Period to account for the decay of Class B and C wastes.

Because the waste stored at the Barnwell facility exhibits long-term stability, the need for active maintenance after site closure is likely to be minimal. Specifically, this stability prevents water infiltration due to failure of the disposal unit covers and, therefore, reduces the potential for leachate to impact ground water. In addition, stability also plays an important role in protecting an inadvertent trespasser, since the stable waste form is recognizable for a long time and minimizes any effects from dispersion of the waste upon intrusion.

4.3.2 Suspended Operations Scenario

Under State law, disposal operations may be suspended if revenues are not sufficient to cover the allowable operating costs and operating margin. The need to suspend operations is most

probable during the In-Region Operations period where annual waste volumes are estimated at 8,000 cubic feet per year. This is substantially different from the estimates of FY 2002/2003 through 2007/2008, which are on the order of 70,000 decreasing to 35,000 cubic feet per year. The current In-Region Operations period is expected to have a 30-year duration.

The PSC determined that operating costs for fiscal year 2001 were $11,282,799, including the site operator's margin. At average disposal rates of $500 per cubic foot, it would require the disposal fees of charged for disposal of 22,486 cubic feet of waste to cover the operating costs. While the annual operating costs incurred during the In-Region Phase will be reduced because of the smaller volumes of waste being disposed, it is problematic whether the disposal fees generated by the approximately 8,000 cubic feet of waste that will be disposed annually during the In-Region Phase will be sufficient to cover operating expenses.

Suspension of operations should be avoided since any response will require additional effort to stabilize the site for such time as operations are suspended, followed by a decision to maintain, or reduce staff, including the impact on programs supported by waste receipts, or the Extended Care Fund. Additionally, resumption of operations is typically more burdensome where operations are suspended due to some unforeseen event. In any event, the costs associated with reaction and recovery would probably not be covered by waste receipts and, subsequently, have to be borne by the extended care fund.

Suspension of waste burial operations while still receiving waste on site would most likely result in an increase in costs because an interim storage area would have to be constructed and maintained. In addition, the level of monitoring surveillance and maintenance would have to be maintained – if not increased – to evaluate activities at the interim storage facility. Further, upon resumption of operations, the waste would have to be moved from the interim facility to the final storage area, resulting in increased labor fees associated with double-handling the waste material. Funding of these activities could place an additional burden on the Extended Care Fund.

In addition to increased operating costs, surcharges to reimburse the Licensee PSC, Compact Commission and State Treasurer may need to be considered. During periods of suspended operations, the site operator must be reimbursed by the Licensee from the Extended Care Fund for both its allowable costs and operating margin. Subsequently, the funding to reimburse the Licensee, the PSC, and the State Treasurer under Section 48-46-60(B), including the compact commission under Section 48-46-60(C), must also be allocated from the Extended Care Fund.

The Chem-Nuclear 2001-2002 Least Cost Operating Plan, which is required to be updated annually, is essentially a ten-year financial plan for the Barnwell facility. The plan predicts net revenues during the In-Region Operations period to only marginally exceed costs. Additionally, the majority of the waste received will probably be the result of D&D activities, which means large components will comprise the majority of the waste volume in any given year. Any schedule variation with the waste generator could have a significant impact on the waste receipts generated in any given year.

More probable is that burial operations would be handled in a campaign style. Current operations assume consistent workload throughout the year. However, it is likely that burial operations during the In-Region Operations period would be more efficient if an operating window were established based on known waste volumes and receipts for a given year. If burial practices were conducted in this manner, the core staff would be supplemented for a given duration of work, and trench and burial practices could be optimized to support this change in disposal site operations. Consequently, it is unlikely that the Extended Care Fund would be impacted, as monitoring surveillance and maintenance requirements would remain relatively constant for the period of suspended operations. The primary purpose of a scheduled suspension of operations would be to prevent having to use the Extended Care Fund to pay operator reimbursements, including other taxes and fees, which could not otherwise be covered through waste receipts.

Therefore we note that suspension of operations should be avoided because the scenarios evaluated in this report indicate little margin for expenditures outside those necessary for the extended care activities set forth herein.

4.3.3 CERCLA Applicability

BB&J evaluated the applicability of the CERCLA as a potential source of funding in the event that Extended Care Funds prove insufficient to address necessary remedial requirements. The following sections present BB&J's findings, which are based on review of current CERCLA regulations and information associated with the former Maxey Flats LLRW disposal facility (Maxey Flats) located near Morehead, Kentucky. Maxey Flats was chosen because it was a LLRW facility and its current status as a CERLCA site.

4.3.3.1 Background

Maxey Flats began operations under a lease arrangement between the Commonwealth of Kentucky and the Nuclear Engineering Company (now US Ecology, Inc.) of Louisville, Kentucky in January 1963. LLRW was buried at Maxey Flats in 51 trenches measuring up to 650 feet long, 70 feet wide, and 30 feet deep. Disposal operations ceased in 1977. Over the 14-year lifespan of the Maxey Flats facility, more than five million cubic feet of LLRW were accepted for disposal. The facility was closed after it was determined that ground water impacted by radionuclides was detected in other areas of the facility. From 1973 to 1986, the Commonwealth of Kentucky conducted an interim measure consisting of ground-water removal by pumping with the storage of concentrates derived from the low-level radioactive ground water in above ground tanks. In 1986, the Maxey Flats facility was added to the National Priorities List by the EPA and numerous potentially responsible parties (PRPs) were identified as liable for cleanup under CERCLA. In 1989, the EPA solidified the concentrates removed during the ground-water remediation effort and reburied them at the Maxey Flats facility. In June 1995, the PRP group reached a settlement with the EPA to conduct remediation of the Maxey Flats facility consisting of additional ground-water removal and the installation of an interim cap. Currently, the Maxey Flats facility is undergoing ground-water remediation, which is expected to be

completed by 2003. It should be noted that the Maxey Flats facility and its associated remedial activities are discussed in this section only as an example of application of CERCLA regulations to a LLRW facility requiring remedial action. As described in Section 4.2.4, this report considers the potential for remedial action at the Barnwell facility to be low.

4.3.3.2 Applicability of CERCLA

When passed and signed into law in 1980, CERCLA was not applicable to LLRW disposal sites. However, in 1986, the Superfund Amendment and Reauthorization Act (SARA) amended CERLCA and gave the EPA the authority to implement investigation and cleanup activities in accordance with CERCLA at any waste disposal facility that accepted waste managed by the DOE under Part 300 of the National Oil and Hazardous Substances Contingency Plan (NCP). As a result, the EPA added Maxey Flats to the NPL in 1986 primarily because the DOE and several other federal agencies had disposed of LLRW at the Maxey Flats facility. Based on the regulatory history of Maxey Flats, it appears that CERCLA would be applicable to the Barnwell facility if DOE managed radioactive wastes have been accepted for disposal and in the unlikely event of remedial action.

4.3.3.3 Potentially Responsible Parties

In 1986, the EPA identified 832 PRPs, including the DOE, Department of Defense, and the Commonwealth of Kentucky. According to Fazi Sherkat, Superfund Branch Manager for the Kentucky Division of Waste Management, the identified PRPs were essentially those parties that disposed of any quantity of LLRW at the Maxey Flats facility. From 1986 until 1995, several of the smaller PRPs reached financial settlements with the EPA or the PRP group. In June of 1995, the remaining PRPs, consisting of 400 parties, reached a settlement (1995 Settlement) with the EPA to conduct a $60 million remediation effort at the Maxey Flats facility. The majority of the cleanup costs, which were estimated to be $45 million, were to be funded by the United States Army, Air Force, DOE, Navy, National Aeronautics and Space Administration, and the National Institute of Health, with the remainder to be funded by Commonwealth of Kentucky and private

PRPs. Approximately 40 percent of the entire cleanup cost will be paid by the DOE. The 1995 Settlement also required the federal and private PRPs to pay $5 million of the EPA's costs incurred during implementation of interim measures at the facility. The 1995 Settlement further required state, federal and private PRPs to pay $8.5 million toward interim measures costs incurred prior to 1995. According to Mr. Sherkat, the interim measures implementation by the Commonwealth of Kentucky and EPA were initially paid for by general funds and not by an established Extended Care Fund. Based on the identification and management of PRPs at Maxey Flats, it would appear that any state, federal, or private party that disposed of LLRW at a similar facility would be a prospective PRP if the facility were listed on the NPL.

4.3.3.4 Extended Care

Based on the terms of the 1995 Settlement, after completion of the remedial activities, installation of an interim cap and completion of initial closure support construction activities, the Commonwealth of Kentucky is responsible for the long-term stewardship of the Maxey Flats site. Stewardship activities will consist of the following:

- Maintenance of the facility fencing;
- Maintenance and updating of facility records;
- Long-term monitoring;
- Annual inspections; and,
- Installation and maintenance of a final Subtitle C cap after disposal trenches have subsided and the waste material has stabilized.

Ground-water monitoring will be conducted for two five-year periods to evaluate the effectiveness of the remedial measures. According to Mr. Sherkat, monies for the long-term

stewardship activities will be drawn from a state-funded Post-Closure trust. In addition, a state-funded emergency/disaster fund will also be maintained for the Maxey Flats facility. Because there appears to have been no formal Extended Care Fund in existence for the Maxey Flats site prior to the 1995 Settlement, it is unclear whether such a fund would have to be exhausted prior to using CERCLA funds for closure-related activities. However, based on the funding history of Maxey Flats, in the event that the Barnwell facility were listed on the NPL, it may be possible to apply CERCLA-derived monies from PRPs to fund interim measure and remediation costs, while Extended Care Funds could be set aside for long-term care. Please note that the aforementioned remedial activities described for the Maxey Flats facility are discussed only as an example of how CERCLA regulations might be applied to a LLRW facility. As discussed in Section 4.2.4, we consider the probability for remedial action at the Barnwell facility to be low.

5.0 FINANCIAL CONSIDERATIONS

Two of the most important characteristics of a successful Extended Care Fund for the institutional control of the Barnwell facility are financial adequacy and security. This section will address both of these factors as they pertain to the Barnwell facility. As discussed in the following sections, the State Treasurer's Office currently manages three separate accounts associated with the Barnwell facility. As Trustee of the Funds, the State Treasurer has the responsibility to ensure the financial security of the funds. In order to provide fund security, the Treasurer must have sufficient confidence in the securities in which the funds are invested and simultaneously maximize the return on the investments, while minimizing the risk associated with those investments.

The financial markets offer a wide spectrum of investment opportunities ranging from the least risky to the very risky. In general, there is an inverse relationship between risk and return. The less risk associated with an investment instrument, the lower the rate of return one can expect that investment instrument to yield. At one end of this spectrum are investment instruments that have little or no risk such as Federally guaranteed securities. These securities pay a guaranteed but relatively low rate of return. At the other end of the spectrum are investment opportunities

that have a great deal of risk such as venture capital funds. These can return extremely high yields to the investor but are very risky and are not guaranteed. As discussed in the following sections, the overall rate of fund growth will determine whether the long-term objectives for the facility can be achieved.

5.1 Investment and Rate of Return Expectations

As stated above, there are three separate accounts with funds from the Barnwell facility that are managed by the South Carolina Treasurer. However, two of the accounts (Acct # E164042 and E164044) are for site closure and one is designated for Long-Term Care (Acct # E164693). The two site closure accounts totaled $19.16 million as of September 30, 2001, but only the Long-Term Care Fund balance will be considered throughout the remainder of this analysis. The State Treasurer is responsible for hundreds of such funds for a variety of purposes. In order to help facilitate the management of these funds, the Treasurer pools funds that have certain similarities, such as use, investment restrictions, maturity, etc. The Barnwell accounts are pooled with several other funds. The three funds and their respective balances as of 9/30/01 are as follows:

	Closure Chem-Nuclear Principal (Acct # E164042)	**Closure Chem-Nuclear Interest (Acct # E164044)**	**Long-Term Care Atomic Waste Burial Fund (Acct # E164693)**
Balance as of 9/30/01	$18,585,446	$570,780	$68,752,827

The following table indicates the respective yields for the three funds since 1995:

Year	Closure Chem-Nuclear Principal (Acct # E164042)	Closure Chem-Nuclear Interest (Acct # E164044)	Long-Term Care Atomic Waste Burial Fund (Acct # E164693)
1995	7.07%	6.12%	6.02%
1996	7.36%	6.04%	6.08%
1997	7.30%	6.22%	6.24%
1998	6.87%	6.27%	6.24%
1999	6.92%	5.88%	5.86%
2000	6.80%	6.05%	6.09%
2001	6.61%	6.58%	6.50%
9/30/01	5.47%	5.79%	5.89%

The yields from the Barnwell accounts in the table above are not adjusted for inflation (i.e., "nominal terms"). When evaluating returns for a relatively short-term horizon, it is appropriate to focus on nominal rates of return. However, in evaluating the long-term, especially a period of 100 years or more, it is more appropriate to isolate the effects of inflation and focus on the real rate of return.

The "real rate of return" is defined as the nominal rate of return minus the inflation rate. In the evaluation of the Barnwell funds for the next 140 years, it is more appropriate to utilize real rates of return rather than nominal rates of return. The cost estimates are estimated using current, non-inflationary dollars. Given this, real rates of return are utilized throughout this analysis.

In this analysis, the expected yield for the Barnwell funds is critically important in evaluating the adequacy of the funds over the 140-year time horizon. Of course, no one can be certain of the rates of return that the funds will yield in the short term, much less during this long period. Likewise, no one knows what the pattern of inflation will be over the next 140 years. Nonetheless, it is necessary and appropriate to assume that the funds will generate interest earnings.

History can provide a reasonable guide in formulating an estimate for the long-term yields that can be assumed for these funds. Since the early 1960's, long-term government guaranteed U.S. Treasury securities have yielded an average annual rate of return of about 7.6%. Short-term U.S. Treasury's have averaged a slightly lower annual average rate of return of about 6.8%. During this period, inflation as measured by the All-Item Consumer Price Index (CPI) averaged slightly over 4.6% a year. Thus, the real rate of return for U.S. Treasury guaranteed securities has averaged between 2.15% and 2.97%, depending on the length of the security's maturity.

However, it must be noted that these are merely mathematical averages and there have been periods during which the real rate of return was well below these averages. For example, during the mid-to-late 1960's, the real rate of return was consistently below 2%. In fact, there have been periods during which the real rate of return on guaranteed securities was negative as in the early and the late 1970's where the real rate of return on 20-year U.S. securities was minus 2%. On the other hand, the real rate of return has been above these average levels also. In the early 1980's, the real rate of return reached over 8%.

As they have in the past, real rates of return will fluctuate over the next 140 years. Although it is certain that the real rate of return on the Barnwell fund accounts will vary over the 140-year period, the exact timing and magnitude of the fluctuations are unknown. However, the use of an average rate of return is appropriate – especially given the long-term horizon – because over such a long period, the fluctuation in rates tends to offset one another and become a more accurate an indicator of the real rate over time.

For the purposes of this analysis, it is assumed that the Barnwell accounts earn annual real rate of return of 2.0%.[1] This is below the real rate of return of 20-year U.S. securities over the last 40 years, but it is only 0.15% (or 15 "basis points") below the average annual real rate of return for short-term securities. The pattern, yields, and maturities of the Treasurer's investments as well as the timing and magnitude of the withdrawal of funds for the next 100 years or so are unknown and are subject to change. As such, it is unreasonable to assume that the Treasurer's Office will

[1] The real rate of return assumed by Chem-Nuclear in their analysis is also 2.0%.

always be able to invest these funds in long-term securities. Therefore, it is appropriate to assume that the Treasurer will not always be able to earn rates of return consistent with the maximum rate of return corresponding to long-term securities for the entire period. In fact, according to the Treasurer's Office, most of the pools the funds are currently invested in are in pools of funds invested in shorter-term securities. Only the Chem-Nuclear Account # E164042, with a balance as of 9/30/01 of $18.5 million, was in a long-term pool. The other accounts were in shorter-term pools.

Given this, it is appropriate in this analysis to assume a real rate of return below that of historical long-term securities and one that is more consistent with the yields of shorter-term securities. A 140-year planning horizon is considered too long to be able to anticipate all of the factors that the Treasurer's Office would encounter. Therefore, it is deemed appropriate in this analysis to assume that the funds will yield real rates of return closer to the historical average for the real rate of return for short-term securities than for longer-term securities. The 2.0% rate incorporated in this analysis is slightly below that of the historical average rate that short-term securities have yielded. The difference between the assumed rate of 2% and the historical rate of 2.15% can be considered a contingency factor.

5.2 Fund Security

The security of the funds is of utmost importance to the integrity of the entire closure process, and maintaining an adequate balance between risk and yield ensures that the appropriate closure and maintenance activities are adequately funded. If there are insufficient funds in the accounts to cover the costs of maintenance and closure someone else (such as the general taxpayers of South Carolina), will have to fund the activities from general taxes or other sources of income.

The State Treasurer is limited in his range of options for investment securities for the accounts containing Barnwell funds. According to the 1981 Trust Agreement, these securities must be in high-grade, guaranteed or AAA investment securities. There appears to be no reason for the Treasurer to alter the investment strategy of these accounts in terms of the quality or type of

securities the funds are invested. Over the last several years, the yields on the pools containing the Barnwell accounts have returned real rates of interest well above the historical averages. Since 1995, the accounts have earned a real rate of return above 3.5%. These types of investment instruments provide a reasonable rate of return while providing the state the lowest level of risk.

6.0 FINDINGS FROM FINANCIAL ANALYSIS

According to the State Treasurer's Office, the funds in the Barnwell Long-Term Care account totaled $68,752,827 as of September 30, 2001. However, the initial period in this analysis is the year 2002-2003. Therefore, the fund's balance was estimated to increase to $72,534,232 as of July 1, 2002 (an annual increase of 5.5%).[2] Throughout this analysis and in all of the scenarios, the beginning balance is assumed to be $72,534,252. Although there may be additional burial fees added to the funds and expenses deducted between the time of this analysis and 2002-2003, it was deemed appropriate to conduct the analysis with a known beginning balance. In addition, based on our understanding that the extended care activities may be procured through a competitive bid process by the State of South Carolina, Chem-Nuclear's proposed 29% fee associated with Phase I Post-Closure and Long-Term Care during the 100-year institutional control period has been reduced to 15%.

It is important to note that Chem-Nuclear used a beginning balance of about $95 million in all of their analyses instead of the disclosed Treasurer's Office balance of $72.5 million. The source of the $95 million figure is unclear, but may have included the two other accounts designated for site Closure. The calculations discussed herein indicate that if a $72.5 million beginning balance and the cost estimates presented by Chem-Nuclear are assumed to be accurate, funds will be depleted prior to the completion of activities under a private sector approach. The following paragraphs summarize our findings for several scenarios under the public and private sector approach. Calculations associated with the findings for the scenarios are presented in Tables 3 through 13.

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[2] As of September 30, 2001, the funds were earning a return of 5.89% per the State Treasurer's Office.

Findings for Scenario 1 – Public Sector (Base Case scenario with stepwise reduction in monitoring and maintenance levels during the institutional control period)

The following section evaluates the fund balances associated with the Base Case as detailed in Table 6 in the attached spreadsheets. Based on the costs assumed in the Base Case and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would have a balance of $30.7 million in the year 2143-2144. However, as shown in the following table, the ending balance is dramatically affected by the return on the fund. For example, if the fund yields a real rate of return that averages 2.1% a year, the ending balance would be over $97 million. However, if the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2131 and have a negative balance of -$21.1 million in the year 2143.

Scenario 1 – Public Sector (Base Case)

Average Annual Rate of Return	**Beginning Fund Balance**	**Ending Fund Balance**
2.1%	$72,534,232	$97.3 mil
2.0%	$72,534,232	$30.7 mil
1.9%	$72,534,232	$ -21.1 mil

As the table above indicates, a slight variation in the average annual real rate of return has a dramatic impact on the fund's ending balance. This sensitivity analysis was extended to evaluate what level of real interest rate would have to exist for the fund to have a zero balance in the year 2143-2144. Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 1.95% in order for the fund to have a zero balance at the end of the period. This is very close to the average rate assumed to be appropriate for this analysis as discussed in Section 5.1 above.

Another way of evaluating the fund balance requirements is to evaluate what level of funds are needed today in order to achieve a desired balance in the year 2143-2144. For example, if a real rate of return of 2.0% is assumed and the State desires a zero balance at the end of the period, what should the fund balance be today? The following table highlights this approach with several options. The assumptions are that the fund earns an annual real rate of return that ranges from 1.9% to 2.1% and that the desired ending balance is between 0 and $50,000,000.[3]

Scenario 1 – Public Sector (Base Case)

Average Annual Real Rate of Return	**Ending Balance Desired**	**Beginning Balance Required**
2.1%	$50 mil	$70.1 mil
2.1%	$20 mil	$68.5 mil
2.1%	$ 0 mil	$67.4 mil
2.0%	$50 mil	$73.7 mil
2.0%	$20 mil	$71.9 mil
2.0%	$ 0 mil	$70.7 mil
1.9%	$50 mil	$77.6 mil
1.9%	$20 mil	$75.5 mil
1.9%	$ 0 mil	$74.2 mil

As seen in the third column of the table above, the variation in the beginning fund balance is relatively small even when the desired ending balance varies by $50 million. Taking the extremes of the above case, a minimum beginning fund balance of $67.4 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired

[3] To add an additional layer of contingency the State may want to plan to have a balance above zero in the year 2143-2144. If the fund were to end with a positive balance, the State could disperse the remaining funds at that time according to a predetermined strategy.

ending balance is $50 million. In that case, the required beginning balance is $77.6 million. Even if the ending balance differs by $50 million and the average annual real rate of return varies by 20 basis points, the difference in beginning balances is only about $10 million. The table above demonstrates one of the fundamental findings of this analysis, the importance of having a substantial fund balance today.

Findings for Scenario 2 - Public Sector Approach (monitoring and maintenance levels remaining constant and no remedial action)

The following section evaluates the fund balances associated with the Scenario 2 – Public Sector as detailed in Table 7 in the attached spreadsheets. Based on the costs assumed in Scenario 2 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would have a balance of just $1.1 million in the year 2143-2144. However, as shown in the following table, the ending balance is substantially affected by the rate of return on the fund. For example, if the fund yields a real rate of return that averages 2.1% a year, the ending balance would be about $66.5 million. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2121 and would have a negative balance of -$42.3 million in the year 2143.

Scenario 2 – Public Sector

Average Annual Rate of Return	**Beginning Fund Balance**	**Ending Fund Balance**
2.1%	$72,534,232	$66.5 mil
2.0%	$72,534,232	$1.1 mil
1.9%	$72,534,232	-$42.3 mil

For each of the remaining five scenarios evaluated herein, slight variations in the average annual real rate of return have a dramatic impact on the fund's ending balance. This sensitivity analysis was extended to evaluate what level of real interest rate would have to exist for the fund to have a zero balance in the year 2143-2144 for each scenario as well as evaluating the fund balance

requirements is to evaluate what level of funds are needed today in order to achieve a desired balance in the year 2143-2144.

Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 1.998% in order for the fund to have a zero balance at the end of the period. This is very close to the average rate assumed appropriate for this analysis as discussed in Section 5.1 above.

As seen in the third column of the following table, the variation in the beginning fund balance is relatively small even when the desired ending balance varies by $50 million. Taking the extremes of the above case, a minimum beginning fund balance of $69.1 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $79.6 million. As with Scenario 1 (Base Case), even if the ending balance differs by $50 million and the average annual real rate of return varies by 20 basis points, the difference in beginning balances is only about $10 million.

Scenario 2 – Public Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$71.7 mil
2.1%	$20 mil	$70.1 mil
2.1%	$ 0 mil	$69.1 mil
2.0%	$50 mil	$75.5 mil
2.0%	$20 mil	$73.7 mil
2.0%	$ 0 mil	$72.5 mil
1.9%	$50 mil	$79.6 mil
1.9%	$20 mil	$77.5 mil
1.9%	$ 0 mil	$76.1 mil

Findings for Scenario 3 - Public Sector Approach (stepwise reduction in monitoring and maintenance levels during the institutional control period and including a remedial action)

The following section evaluates the fund balances associated with the Scenario 3– Public Sector as detailed in Table 8 in the attached spreadsheets. Based on the costs assumed in Scenario 2 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would exhaust itself in the year 2127 and have a negative balance of -$27.9 million in the year 2143-2144. As shown in the following table, the ending balance is substantially affected by the rate of return on the fund. For example, if the fund yields a real rate of return that averages 2.1% a year, the ending balance would be about $28.0 million. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2108 and would have a negative balance of -$58.0 million in the year 2143.

Scenario 3 – Public Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$28.0 mil
2.0%	$72,534,232	-$27.9 mil
1.9%	$72,534,232	-$58.0 mil

As with the other scenarios, a slight variation in the average annual real rate of return has a dramatic impact on the fund's ending balance. Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 2.06% in order for the fund to have a zero balance at the end of the period.

As seen in the third column of the following table, the variation in the beginning fund balance is relatively small even when the desired ending balance varies by $50 million. Taking the extremes of the Scenario 3 case, a minimum beginning fund balance of $71.1 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $81.6 million. As with the other Scenarios, even if the ending balance differs by $50 million and the average annual real rate of return varies by 20 basis points, the difference in beginning balances is only about $10 million.

Scenario 3 – Public Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$73.7 mil
2.1%	$20 mil	$72.1 mil
2.1%	$ 0 mil	$71.1 mil
2.0%	$50 mil	$77.5 mil
2.0%	$20 mil	$75.7 mil
2.0%	$ 0 mil	$74.5 mil
1.9%	$50 mil	$81.6 mil
1.9%	$20 mil	$79.5 mil
1.9%	$ 0 mil	$78.2 mil

Findings for Scenario 4 - Private Sector Approach (stepwise reduction of monitoring and maintenance levels during the institutional control period)

The following section evaluates the fund balances associated with the Scenario 4 – Private Sector as detailed in Table 11 in the attached spreadsheets. Based on the costs assumed in Scenario 4 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would exhaust itself in the year 2133 and have a negative balance of -$19.7 million in the year 2143-2144. As shown in the following table, the ending balance is substantially affected by the rate of return on the fund. For example, if the fund yields a real rate of return that averages 2.1% a year, the ending balance would be about $41.4 million. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2113 and would have a negative balance of -$54.6 million in the year 2143.

Scenario 4 – Private Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$41.4 mil
2.0%	$72,534,232	-$19.7 mil
1.9%	$72,534,232	-$54.6 mil

As with the other scenarios, a slight variation in the average annual real rate of return has a dramatic impact on the fund's ending balance. Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 2.04% in order for the fund to have a zero balance at the end of the period.

As seen in the third column of the table below, the variation in the beginning fund balance is relatively small even when the desired ending balance varies by $50 million. Taking the extremes of the Scenario 4 – Private Sector case, a minimum beginning fund balance of $70.4 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $81.0 million. As with the other Scenarios, even if the ending balance differs by $50 million and the average annual real rate of return varies by 20 basis points, the difference in beginning balances is relatively small. In this case, the difference is about $11 million.

Scenario 4 – Private Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$73.0 mil
2.1%	$20 mil	$71.4 mil
2.1%	$ 0 mil	$70.4 mil
2.0%	$50 mil	$76.8 mil
2.0%	$20 mil	$75.0 mil
2.0%	$ 0 mil	$73.8 mil
1.9%	$50 mil	$81.0 mil
1.9%	$20 mil	$78.9 mil
1.9%	$ 0 mil	$77.5 mil

Findings for Scenario 5 - Private Sector Approach (monitoring and maintenance levels remaining constant and no remedial action)

The following section evaluates the fund balances associated with the Scenario 5 – Private Sector as detailed in Table 12 in the attached spreadsheets. Based on the costs assumed in Scenario 5 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would exhaust itself in the year 2123 and have a negative balance of -$42.1 million in the year 2143-2144. As with the other scenarios, the ending balance is substantially affected by the rate of return on the fund. For example, if the fund yields a real rate of return that averages 2.1% a year, the ending balance would be about $10.6 million. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2108 and would have a negative balance of -$72.1 million in the year 2143.

Scenario 5 – Private Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$10.6 mil
2.0%	$72,534,232	-$42.1 mil
1.9%	$72,534,232	-$72.1 mil

As the table above indicates, a slight variation in the average annual real rate of return has a dramatic impact on the fund's ending balance. Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 2.08% in order for the fund to have a zero balance at the end of the period.

As seen in the third column of the following table, the variation in the beginning fund balance is relatively small even when the desired ending balance varies by $50 million. Taking the extremes of the Scenario 5 – Private Sector case, a minimum beginning fund balance of $72.0 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $83.0 million. As with the other Scenarios, even if the ending balance differs by $50 million and the average annual real rate of return varies by 20 basis points, the difference in beginning balances is relatively small. In this case, the difference is about $11 million.

Scenario 5 – Private Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$74.6 mil
2.1%	$20 mil	$73.0 mil
2.1%	$ 0 mil	$72.0 mil
2.0%	$50 mil	$78.6 mil
2.0%	$20 mil	$76.8 mil
2.0%	$ 0 mil	$75.6 mil
1.9%	$50 mil	$83.0 mil
1.9%	$20 mil	$80.9 mil
1.9%	$ 0 mil	$79.5 mil

Findings for Scenario 6 - Private Sector Approach (stepwise reduction in monitoring and maintenance during the institutional control period and including a remedial action)

The following section evaluates the fund balances associated with the Scenario 6 – Private Sector as detailed in Table 13 in the attached spreadsheets. Based on the costs assumed in Scenario 6 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would exhaust itself in the year 2110 and have a negative balance of -$60.6 million in the year 2143-2144. As with the other scenarios, the ending balance is substantially affected by the rate of return on the fund. For example, if the fund yields a real rate of return that averages 2.1% a year, the fund would exhaust itself in the year 2130 and would have a negative balance of -$24.6 million in the year 2143-2144. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2096 and have a negative balance of -$82.9 million in the year 2143.

Scenario 6 – Private Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	-$24.6 mil
2.0%	$72,534,232	-$60.6 mil
1.9%	$72,534,232	-$82.9 mil

As the table above indicates, a slight variation in the average annual real rate of return has a substantial impact on the fund's ending balance. Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 2.14% in order for the fund to have a zero balance at the end of the period.

As seen in the third column of the table below, the variation in the beginning fund balance is relatively small even when the desired ending balance varies by $50 million. Taking the extremes of the Scenario 6 – Private Sector case, a minimum beginning fund balance of $74.0 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $85.0 million. As with the other Scenarios, even if the ending balance differs by $50 million and the average annual real rate of return varies by 20 basis points, the difference in beginning balances is relatively small. In this case, the difference is about $11 million.

Scenario 6 – Private Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$76.6 mil
2.1%	$20 mil	$75.0 mil
2.1%	$ 0 mil	$74.0 mil
2.0%	$50 mil	$80.6 mil
2.0%	$20 mil	$78.8 mil
2.0%	$ 0 mil	$77.6 mil
1.9%	$50 mil	$85.0 mil
1.9%	$20 mil	$82.9 mil
1.9%	$ 0 mil	$81.5 mil

Comparing all six Scenarios together provides a range of beginning fund balances necessary to meet the State's objectives. Based on this analysis, the minimum balance required would be $67.4 million. This would be the balance required under the following conditions: (1) if costs are those assumed in Scenario 1 (Base Case); (2) if the funds earn 2.1% a year; and (3) the State desires an ending balance of zero in the year 2143-2144. If the rate of return were only 2.0%, then the beginning balance would need to be $70.7 million.

At the other extreme would be the fund balance required under Scenario 6 – Private Sector. Given the following conditions; (1) the costs that are incorporated in Scenario 6; (2) if the funds earn only 1.9% a year; and (3) the State desires an ending fund balance of $50 million, the beginning fund balance required is $85.0 million. The required fund balance would decrease to $80.6 million if the funds earned 2.0% a year.

Range of Fund Balances Needed as of 7/1/02

(Assumes Funds yield 2.0% real rate of return)

Publicly Managed:

Minimum	Maximum
$70.7 million (Scenario 1)	$77.5 million (Scenario 3)

Privately Managed:

Minimum	Maximum
$73.8 million (Scenario 4)	$80.6 million (Scenario 6)

In summary, if the Long-Term Care fund yields an average real rate of return of 2.0% for the 140-year period, it appears that the funds' estimated account balance of $72.5 million as of 7/1/02 is at the very low end of the acceptable range if the State of South Carolina manages the facility. If the State desires an ending balance of $20 million, given the assumptions outlined here, the fund is barely adequate. If the State desires an ending balance of $50 million, given the assumptions outlined herein, the fund is not adequate.

If the facility is managed by the private sector, the current balance of the Long-Term Care fund appears to be inadequate if the funds earn a real rate of return of 2.0%. To assure adequate funds will be in the account to fund the necessary costs of maintenance, provide an ending balance above zero and to weather any substantial periods of below normal real rates of return on the funds over the next 140 years, the State will need to adjust costs, increase the flow of funds to the account or hope real interest rates are consistently above historical levels.

7.0 POTENTIAL MODIFICATIONS TO ASSUMPTIONS

Based on BB&J's review of Chem-Nuclear's cost worksheets provided in the document titled *Financial Data for Interim Site Stabilization and Closure Plan For the Barnwell Low-Level Radioactive Waste Disposal Facility 2000 Closure Plan* dated September 2000 (Chem-Nuclear 2000 Closure Plan), BB&J identified certain costs which we feel should be reevaluated in an

effort to address the projected shortfall in the Extended Care Fund under a private sector approach:

- Laboratory Expenses;
- Technician Labor; and,
- Facility Performance Evaluations.

These costs are discussed in detail in the following sections, and estimated the cost reductions are presented in Tables 14 through 24.

7.1 Laboratory Expenses

BB&J reviewed the proposed laboratory costs presented on page 16 of the Chem-Nuclear 2000 Closure Plan associated with ground-water monitoring requirements for the Barnwell facility, and compared the prices to other labs located both within and outside the State of South Carolina. In most cases, the costs used by Chem-Nuclear in the Chem-Nuclear 2000 Closure Plan exceeded (i.e., by greater than 50%) prices provided by the other labs for the following analyses:

- Base/neutral semivolatile organic compounds (SVOC);
- Acid SVOCs;
- Volatile organic compounds; and,
- Chemical oxygen demand.

The Chem-Nuclear 2000 Closure Plan presents estimated laboratory fees of $455,714 per year. However, if an alternate South Carolina-based laboratory were used for the non-radiological

analyses, the estimated laboratory fees would be $429,946 per year (Refer to Tables 25 and 26). Given the reduced laboratory fees, $18,652,537 would be saved over the course of extended care period assuming a 2.0% real rate of return. In addition, greater savings may potentially be realized if the project can allow for use of an out-of-state, but South Carolina-accredited, laboratory.

7.2 Technician Labor

According to Section 6.2.3.2 of Chem-Nuclear's FY 2001/2002 Least Cost Operating Plan (referenced in the Chem-Nuclear 2000 Closure Plan), three full-time (i.e. 40 hours per week) technicians will be employed at the Barnwell facility as part of the proposed long-term care labor staff. These technicians will include a health physics/environmental technician, an equipment operator, and an individual with equipment/building maintenance capabilities (Maintenance Technician).

However, based on the building and equipment descriptions provided in the Least Cost Operating Plan, a full-time Maintenance Technician may not be required. Section 4.3 of the Least Cost Operating Plan describes 11 buildings present on the property, many of which consist of warehouse-type buildings or maintenance shops. Consequently, these buildings should require minimal regular maintenance as they lack plumbing and HVAC systems. Section 4.5 presents a list of equipment present at the site, including: mobile cranes, earth moving/grading equipment, tractors, mowers, electrical generators, forklifts, trucks, and trailers. Because the site lacks the facilities to make complex repairs to the equipment, the Maintenance Technician will likely be responsible for only routine maintenance tasks while outsourcing the more substantial, time-consuming repairs. In addition, as shown on pages 30 and 31 of the Chem-Nuclear 2000 Closure Plan, many of the heavy vehicles (i.e. tractors, bulldozers, etc.) are rented, and, therefore, Chem-Nuclear may not be responsible for maintenance on this equipment.

If the Maintenance Technician was instead staffed on a part-time basis (i.e. 20 hours per week), $22,986,618 would be saved over the course of extended care period assuming a 2.0% real rate of return.

7.3 Facility Performance Evaluations

As discussed in Section 2.2.2, 10 CFR 61 requires that a Performance Assessment be periodically conducted which re-evaluates the Barnwell facility as operations continue and includes mathematical modeling of radionuclide migration as a function of specific site characteristics. Based on the Chem-Nuclear 2000 Closure Plan, seven Performance Assessments will be conducted during the extended care period. Long-Term Cost Worksheets included in the Chem-Nuclear 2000 Closure Plan identifies an expenditure of $1 million for each Performance Assessment. BB&J attempted to determine the specific scope and costs of these Performance Assessments in order to evaluate whether the $1 million costs may be reduced for those subsequent to the first, which is to be conducted in 2014-2015. Based on a review of *Branch Technical Position on a Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities, NUREG 1573,* (i.e., technical information regarding execution of Performance Assessments on LLRW facilities), a description of the Performance Assessment as given on page 45 of the Chem-Nuclear 2000 Closure Plan, and discussions with DHEC, the primary costs are associated with collection of additional radiological data from various media and evaluation of the data using computer generated models. The actual cost of the components of the Performance Assessment could not be determined because they are not completely itemized in the Chem-Nuclear 2000 Closure Plan. The $1 million cost appears to be based on a January 31, 1992 request for disbursement submitted by DHEC to the South Carolina Budget and Control Board that sets a cap of $1 million for performance of the PA (Refer to Appendix B).

However, as described below, it seems likely that a potential exists for the costs of future PAs to be reduced by the use of models developed for the first event and the potential reduction of monitoring requirements that may occur during the extended care period.

Based on the PA scope described on page 45 of the Chem-Nuclear 2000 Closure Plan, BB&J estimates that personnel expenditures may be reduced for subsequent PAs conducted between 2016 and 2068 by utilizing the existing models developed during the initial PA. BB&J estimates that the reduction would result in an $180,000 decrease in the cost of conducting a PA.

Costs for PAs conducted on or after 2068 could be reduced further by incorporating Chem-Nuclear's assumption that environmental monitoring costs will reduce by 10% after 25 years of institutional control (2068 would mark the 25th year of institutional control). Such an assumption would result in a total cost reduction for conducting a PA by $225,000.

Finally, costs for PAs conducted on or after 2093 could be reduced further by incorporating Chem-Nuclear's assumption that environmental monitoring costs will reduce by 25% after 50 years of institutional control (2093 would mark the 50th year of institutional control). Such an assumption would result in a total cost reduction for conducting a PA by $300,000.

Using the aforementioned potential costs savings for conducting PAs subsequent to the year 2014, BB&J estimates that $2,642,495 would be saved over the course of extended care period assuming a 2.0% real rate of return.

7.4 Summary of Assumptions

Given these alternative cost considerations, the aforementioned potential modifications to the assumptions for extended care period expenditures could significantly reduce the projected shortfall in the Extended Care Fund under the private sector approach through potential projected costs savings of at least $46,644,589 using a real rate of return of 2% over the next 140 years. The impacts on the necessary fund balances outlined in Section 6.0 are substantial.

Ending Fund Balances Under Different Scenarios Assuming Different Real Rates of Interest Earned on Investment

Scenario	2.1% Average Annual Rate of Return	2.0% Average Annual Rate of Return	1.9% Average Annual Rate of Return
Scenario 1	$97.3 million	$30.7 million	$-21.1 million
Scenario 2	$66.5 million	$1.1 million	$-42.3 million
Scenario 3	$28.0 million	$-27.9 million	$-58.0 million
Scenario 4	$41.4 million	$-19.7 million	$-54.6 million
Scenario 5	$10.6 million	$-42.1 million	$-72.1 million
Scenario 6	$-24.6 million	$-60.6 million	$-82.9 million

The following analysis specifies the impact of these possible cost reductions on each of the Scenarios.

Scenario 1 – Public Sector (Base Case)

The following section evaluates the fund balances associated with the Base Case as detailed in Table 17 in the attached spreadsheets. Based on the lower costs assumed in this version of the Base Case and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would have a balance of $73.8 million in the year 2143-2144. If the fund yields a real rate of return that averages 2.1% a year, the ending balance would be over $144 million. If the fund generates only 1.9% a year in real terms, the account will have a balance of $15.9 million in the year 2143.

Scenario 1 – Public Sector (Base Case)

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$144.4 mil
2.0%	$72,534,232	$73.8 mil
1.9%	$72,534,232	$ 15.9 mil

Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 1.869% in order for the fund to have a zero balance at the end of the period.

The following table provides estimates of what level of funds are needed today in order to achieve a desired balance in the year 2143-2144. The assumptions are that the fund earns an annual real rate of return that ranges from 1.9% to 2.1% and that the desired ending balance is between 0 and $50,000,000.[4]

[4] In order to add an additional layer of safety and contingency the State may want to plan to have a balance above zero in the year 2143-2144. If the fund were to end with a positive balance, the State could disperse the remaining funds at that time according to a predetermined strategy.

Scenario 1 – Public Sector (Base Case)

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$67.6 mil
2.1%	$20 mil	$66.0 mil
2.1%	$ 0 mil	$65.0 mil
2.0%	$50 mil	$71.1 mil
2.0%	$20 mil	$69.3 mil
2.0%	$ 0 mil	$68.1 mil
1.9%	$50 mil	$74.9 mil
1.9%	$20 mil	$72.8 mil
1.9%	$ 0 mil	$71.4 mil

Taking the extremes of the above case, a minimum beginning fund balance of $65.0 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $74.9 million. Even if the ending balance differs by $50 million and the average annual real rate of return varies by 20 basis points, the difference in beginning balances is only about $10 million.

Findings for Scenario 2 - Public Sector Approach

The following section evaluates the fund balances associated with the Lower-Cost Scenario 2 – Public Sector as detailed in Table 18 in the attached spreadsheets. Based on the costs assumed in Scenario 2 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would have a balance of just $1.1 million in the year 2143-2144. However, as shown in the following table, the ending balance is substantially affected by the rate of return on the fund. For example, if the fund yields a real rate of return that averages 2.1% a year, the

ending balance would be about $66.5 million. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2121 and would have a negative balance of -$42.3 million in the year 2143.

Scenario 2 – Public Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$113.6 mil
2.0%	$72,534,232	$44.2 mil
1.9%	$72,534,232	-$12.0 mil

For each of the remaining five scenarios with lower costs evaluated herein, slight variations in the average annual real rate of return have a dramatic impact on the fund's ending balance. This sensitivity analysis was extended to evaluate what level of real interest rate would have to exist for the fund to have a zero balance in the year 2143-2144 for each scenario as well as evaluating the fund balance requirements is to evaluate what level of funds are needed today in order to achieve a desired balance in the year 2143-2144.

Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 1.924% in order for the fund to have a zero balance at the end of the period.

Taking the extremes of the above case, a minimum beginning fund balance of $66.1 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $76.9 million.

Scenario 2 – Public Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$69.2 mil
2.1%	$20 mil	$67.6 mil
2.1%	$ 0 mil	$66.6 mil
2.0%	$50 mil	$72.9 mil
2.0%	$20 mil	$71.1 mil
2.0%	$ 0 mil	$69.9 mil
1.9%	$50 mil	$76.9 mil
1.9%	$20 mil	$74.8 mil
1.9%	$ 0 mil	$73.4 mil

Findings for Scenario 3 - Public Sector Approach

The following section evaluates the fund balances associated with the Lower Cost Scenario 3 – Public Sector as detailed in Table 19 in the attached spreadsheets. Based on the costs assumed in Scenario 2 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would have a balance of 10.5 million in the year 2143-2144. If the fund yields a real rate of return that averages 2.1% a year, the ending balance would be about $28.0 million. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2122and would have a negative balance of -$34.4 million in the year 2143.

Scenario 3 – Public Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$75.1 mil
2.0%	$72,534,232	$10.5 mil
1.9%	$72,534,232	-$34.4 mil

Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 1.982% in order for the fund to have a zero balance at the end of the period.

Taking the extremes of the Scenario 3 case, a minimum beginning fund balance of $68.6 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $78.9 million.

Scenario 3 – Public Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$71.2 mil
2.1%	$20 mil	$69.7 mil
2.1%	$ 0 mil	$68.6 mil
2.0%	$50 mil	$74.9 mil
2.0%	$20 mil	$73.1 mil
2.0%	$ 0 mil	$71.9 mil
1.9%	$50 mil	$78.9 mil
1.9%	$20 mil	$76.8 mil
1.9%	$ 0 mil	$75.4 mil

Findings for Scenario 4 - Private Sector Approach

The following section evaluates the fund balances associated with the Lower Cost Scenario 4 – Private Sector as detailed in Table 22 in the attached spreadsheets. Based on the costs assumed in Scenario 4 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would have a balance of $26.9 million in the year 2143-2144..If the fund yields a real rate of return that averages 2.1% a year, the ending balance would be about $94.5 million. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2129 and would have a negative balance of -$24.9 million in the year 2143.

Scenario 4 – Private Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$94.5 mil
2.0%	$72,534,232	$26.9 mil
1.9%	$72,534,232	-$24.9 mil

Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 1.954% in order for the fund to have a zero balance at the end of the period.

Taking the extremes of the Lower Cost Scenario 4 – Private Sector case (Table 22), a minimum beginning fund balance of $67.6 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $77.9 million.

Scenario 4 – Private Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$70.2 mil
2.1%	$20 mil	$68.6 mil
2.1%	$ 0 mil	$67.6 mil
2.0%	$50 mil	$73.9 mil
2.0%	$20 mil	$72.1 mil
2.0%	$ 0 mil	$70.9 mil
1.9%	$50 mil	$77.9 mil
1.9%	$20 mil	$75.9 mil
1.9%	$ 0 mil	$74.5 mil

Findings for Scenario 5 - Private Sector Approach

The following section evaluates the fund balances associated with the Lower Cost Scenario 5 – Private Sector as detailed in Table 23 in the attached spreadsheets. Based on the costs assumed in Scenario 5 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would exhaust itself in the year 2141 and would have a negative balance of -$5.7 million in the year 2143-2144. If the fund yields a real rate of return that averages 2.1% a year, the ending balance would be about $60.4 million. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2119 and would have a negative balance of -$47.7 million in the year 2143.

Scenario 5 – Private Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$60.4 mil
2.0%	$72,534,232	-$5.7 mil
1.9%	$72,534,232	-$47.7 mil

Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 2.01% in order for the fund to have a zero balance at the end of the period.

Taking the extremes of the Lower Cost Scenario 5 – Private Sector case, a minimum beginning fund balance of $69.4 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $80.1 million.

Scenario 5 – Private Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$72.0 mil
2.1%	$20 mil	$70.4 mil
2.1%	$ 0 mil	$69.4 mil
2.0%	$50 mil	$75.9 mil
2.0%	$20 mil	$74.1 mil
2.0%	$ 0 mil	$72.9 mil
1.9%	$50 mil	$80.1 mil
1.9%	$20 mil	$78.0 mil
1.9%	$ 0 mil	$76.6 mil

Findings for Scenario 6 - Private Sector Approach

The following section evaluates the fund balances associated with the Lower Cost Scenario 6 – Private Sector as detailed in Table 24 in the attached spreadsheets. Based on the costs assumed in Scenario 6 and an average annual real rate of interest of 2% accruing to the fund for the entire period, the fund would exhaust itself in the year 2125 and have a negative balance of -$33.1 million in the year 2143-2144. If the fund yields a real rate of return that averages 2.1% a year, the fund would have a balance of $21.9 million in the year 2143-2144. If the fund generates only 1.9% a year in real terms, the account will run out of funds in the year 2107 and have a negative balance of -$62.9 million in the year 2143.

Scenario 6 – Private Sector

Average Annual Rate of Return	Beginning Fund Balance	Ending Fund Balance
2.1%	$72,534,232	$21.9 mil
2.0%	$72,534,232	-$33.1 mil
1.9%	$72,534,232	-$62.9 mil

Based on the beginning balance of $72.5 million, the average annual real rate of return for the 140-year period would have to be 2.067% in order for the fund to have a zero balance at the end of the period.

Taking the extremes of the Lower Cost Scenario 6 – Private Sector case (Table 24), a minimum beginning fund balance of $71.4 million is needed if the fund generates an average annual real rate of return of 2.1% and the desired balance in 2143-2144 is zero. At the other extreme is if the fund only generates a return of 1.9% and the desired ending balance is $50 million. In that case, the required beginning balance is $82.1 million.

Scenario 6 – Private Sector

Average Annual Real Rate of Return	Ending Balance Desired	Beginning Balance Required
2.1%	$50 mil	$74.0 mil
2.1%	$20 mil	$72.4 mil
2.1%	$ 0 mil	$71.4 mil
2.0%	$50 mil	$77.9 mil
2.0%	$20 mil	$76.1 mil
2.0%	$ 0 mil	$74.9 mil
1.9%	$50 mil	$82.1 mil
1.9%	$20 mil	$80.1 mil
1.9%	$ 0 mil	$78.7 mil

Comparing all six Scenarios together provides a range of beginning fund balances necessary to meet the State's objectives assuming the lower cost scenarios. Based on this analysis, the minimum balance required would be $65.0 million. This would be the balance required under the following conditions: (1) if costs are those assumed in the Lower Cost Scenario 1 (Base Case, as shown in Table 17; (2) if the funds earn 2.1% a year; and (3) the State desires an ending balance of zero in the year 2143-2144. If the rate of return were only 2.0%, then the beginning balance would need to be $68.1 million.

At the other extreme would be the fund balance required under Lower Cost Scenario 6 – Private Sector (Table 24). Given the following conditions; (1) the costs that are incorporated in Scenario 6; (2) if the funds earn only 1.9% a year; and (3) the State desires an ending fund balance of $50 million, the beginning fund balance required is $82.1 million. The required fund balance would decrease to $77.9 million if the funds earned 2.0% a year.

Range of Fund Balances Needed as of 7/1/02

(Assumes Funds yield 2.0% real rate of return)

Publicly Managed:

Minimum	Maximum
$68.1 million (Scenario 1)	$74.9 million (Scenario 3)

Privately Managed:

Minimum	Maximum
$70.9 million (Scenario 4)	$77.9 million (Scenario 6)

In summary, if the lower costs are assumed and the Long-Term Care fund yields an average real rate of return of 2.0% for the 140-year period, it appears that the funds' estimated account balance of $72.5 million as of 7/1/02 is in the middle of the acceptable range if the State of South Carolina manages the facility. Even if the State desires an ending balance of $50 million, given the assumptions outlined here, the fund is adequate.

If the facility is managed by the private sector, the current balance of the Long-Term Care fund appears to be barely adequate if the funds earn a real rate of return of 2.0%. If the state desires an ending balance of above zero or if the funds do not earn an average real rate of return of 2%, the fund may be inadequate to cover all expenses over the 140-year period.

TABLES

APPENDIX A

EVALUATION OF STATE EXTENDED CARE PLANS

A.1 Illinois

The Sheffield LLRW disposal facility is located approximately 120 miles west-southwest of Chicago, Illinois and was operated from 1966 until 1978. The disposal area was approximately 20 acres in size surrounded by 170 acres of land serving as a buffer zone. Approximately 3.2 million cubic feet of LLRW was buried in 21 earthen trenches during its operational period.

Closure of the Sheffield facility was resolved in a Settlement Agreement dated May 25, 1988 between US Ecology, Inc. (US Ecology) and the State of Illinois. Closure of the facility consisted of the installation of a low-permeability clay cap over the trenches, purchasing a buffer zone surrounding the 20 acre disposal area, monitoring and maintaining the facility and buffer zone until the operator's obligations of the Settlement Agreement are completed, and providing financial assurances for closure activities and long-term care. The clay cap was installed in 1989. US Ecology purchased the buffer zone along with the State with an option to purchase any or all of the buffer zone from the State for $0.01 per acre. Maintenance and monitoring of the facility is ongoing and is being overseen by the State. A $2.5 million long-term care fund was established to compensate the State for it's future maintenance and monitoring obligations. The monies, including accrued interest, remain in a special fund of the State Treasury and are reserved exclusively for Sheffield LLRW-related expenses. According to a report titled *Sheffield Low-Level Radioactive Waste Disposal Facility Closure & Post-Closure Performance,* dated June 1998, the fund balance as of June 1998 was $3,342,312.

A.2 Kentucky

The Maxey Flats disposal facility (Maxey Flats) is located in Fleming County, approximately 10 miles northwest of the city of Morehead, Kentucky. Maxey Flats began operations under a lease arrangement between the Commonwealth of Kentucky and the Nuclear Engineering Company (now US Ecology, Inc.) of Louisville, Kentucky in January 1963 and operated until 1977. Maxey Flats occupies approximately 280 acres of land, of which approximately 27 acres were used for the construction of 52 disposal trenches. The trenches measure up to 650 feet long, 70 feet wide, and 30 feet deep. Approximately 4.2-million cubic feet of LLRW were accepted for

disposal during the facility's 14-years of operation. The facility was closed after it was determined that ground water impacted by radionuclides was detected in other areas of the facility.

Maxey Flats was placed on the United States Environmental Protection Agency (EPA) National Priorities List (NPL) in 1986. A Remedial Investigation and Feasibility Study were finalized in July 1989 and May 1991, respectively. A remedial action alternative consisting ofnatural stabilization, containment, leachate removal, and treatment was incorporated by the EPA into the final Record of Decision issued September 1991. Specifically, the alternative was broken out into four phases:

- The Initial Closure Period (22 months), during which cap installation was proposed;
- The Interim Maintenance Period (35 to 100 years), which allowed for natural subsidence of the existing trenches and general site maintenance;
- The Final Closure Period (10 months), which will include the installation of a final cap, surface water control features, and monuments; and
- Custodial maintenance period (in perpetuity).

The estimated cost for this remedial alternative is $33.5 million, which is not being paid out of the Post-Closure or emergency/disaster funds, but is being paid for by private potentially responsible parties (PRPs).

After completion of the remedial activities, installation of an interim cap and completion of initial closure support construction activities, the Commonwealth of Kentucky is responsible for the long-term stewardship of Maxey Flats. Monies for the long-term stewardship activities will be drawn from a state-funded Post-Closure trust. In addition, a state-funded emergency/disaster

fund will also be maintained for the Maxey Flats facility. The Post-Closure trust account was $6.5 million while the emergency/disaster fund account was $3 million, both in 1999 dollars.

A.3 Nebraska

US Ecology filed applications with the Nebraska Department of Environmental Quality and the Nebraska Department of Health and Human Services Regulation and Licensure to construct, operate, and close a commercial LLRW disposal facility in Boyd County, Nebraska. The applications were denied on December 18, 1998. As part of the application package, US Ecology proposed providing an up-front fund of $7.9 million to the Radiation Custodial Care Fund for costs associated with institutional control and/or possible remedial care during institutional control. US Ecology projected that the fund would be worth $54 million at the end of the 30-year operational period of the LLRW disposal facility.

A.4 Nevada

The Beatty LLRW disposal facility was the first commercially operated radioactive waste disposal facility to be licensed by the United States Atomic Energy Commission. The authority for regulation of this site was transferred to the State of Nevada shortly after Nevada became an Agreement State in 1972.

The facility is located in Nye County in the Amargosa Desert approximately 105 miles northwest of Las Vegas, Nevada. The site opened in September 1962 and received radioactive waste for burial until December 31, 1992. Since closure of the site, the Rocky Mountain Compact (Colorado, Nevada, and New Mexico) has entered into an agreement with the Northwest Compact (Alaska, Hawaii, Idaho, Montana, Oregon, Utah, and Washington) that allows low-level waste generators in the Rocky Mountain Compact to dispose of their waste at the Richland, Washington LLRW disposal facility (see Section 4.1.8).

US Ecology has completed the state-approved closure plan to stabilize the site and establish proper security measures. The plan was intended to ensure that the LLRW disposed during the

operational phase of the facility continued to remain in a suitable, stable, and safe condition after site closure. The Nevada State Health Division (NSHD) continues to monitor for radioactivity in ground water, air, soil, and vegetation. The NSHD utilizes a perpetual care fund that is managed by the State of Nevada for the monitoring activity and developed from a surcharge on the waste material disposed at the facility. The balance of the perpetual care fund was $10,519,000 as of September 24, 2001.

A.5 New York

The New York State Energy Research and Development Authority (NYSERDA) manages the Western New York Nuclear Service Center (Center), the site of a former nuclear fuel reprocessing plant and a closed LLRW disposal area. The site is located on 3,340 acres of State-owned land approximately 30 miles southeast of Buffalo, near West Valley in Cattaraugus County. As manager of the Center, NYSERDA represents New York State in the U.S. Department of Energy's (DOE) West Valley Demonstration Project and maintains the closed disposal area.

In 1983, NYSERDA took over maintenance of the closed LLRW disposal facility located on 15 acres at the Center. From 1963 to 1975, Nuclear Fuel Services, Inc. disposed of 2.4 million cubic feet of LLRW in the trenches, including waste from nuclear power plants, hospitals, academic and research institutions, industry, governmental facilities, and the nuclear fuel reprocessing plant at the Center.

In the fall of 1992, NYSERDA began several projects to reduce water accumulation in the disposal trenches including a subsurface barrier wall to divert ground water away from a portion of the disposal area; and an impermeable flexible plastic cover to prevent water from infiltrating through the trench covers. According to Ms. Colleen Gerwitz, of NYSERDA, neither a Closure Plan nor Extended Care Funds exist at this time. NYSERDA is paying for the work and has not prepared any estimates of long-term care expenses. A Draft Environmental Impact Statement (DEIS)is under review. NYSERDA also publishes an annual report of monitoring activities. According to Mr. John Krajewski of the New York State Department of Environmental

Conservation, the disposal area (referred to as the State Disposal Area or SDA) is an active Resource Conservation and Recovery Act (RCRA) facility. Mr. Krajewski anticipates that it will take approximately five years before a Record of Decision is finalized.

A.6 Texas

The Texas LLRW Disposal Authority filed an application with the Texas Natural Resource Conservation Commission to construct, operate and close a commercial LLRW disposal facility near Sierra Blanca, Texas that is currently denied. Similar to the Barnwell facility, the Sierra Blanca facility is also designed for Class A and Class B/C disposal units. The Class A units will be excavated to approximately 40 feet below grade and the Class B/C units will be excavated to an approximate depth of 28 feet below grade. The projected operational life of the LLRW disposal facility is 30 years. The application calls for a 5-year closure and decontamination period after the operational period, followed by a 100-year institutional control period. The cost estimate for the institutional control period is $27.6 million in 1992 dollars and covers estimated costs through year 100 of long-term care.

A.7 Utah

Envirocare of Utah, Inc. (Envirocare) operates a commercial LLRW disposal facility approximately 80 miles west of Salt Lake City in Tooele County. The site, which began operating in 1988, is located on an ancient dry lakebed, west of the Cedar Mountains. According to Mr. Ray Nelson, Utah Division of Radiation Control (DRC), the Envirocare site encompasses approximately 640 acres and has five active cells.

The Envirocare facility is licensed to receive two types of wastes. The first type contains both low-level radioactivity with a hazardous waste component (i.e., mixed waste) and the second type of waste contains only a low-level radioactive component. The mixed waste operations are regulated by both the Utah Division of Solid and Hazardous Waste (DSHW) and the DRC, with the DSHW regulating the hazardous waste portion and the DRC regulating the radioactive portion. Wastes that are only radioactive are regulated by the DRC and the NRC. Envirocare

was authorized to store, treat and dispose of mixed waste by a RCRA Part B Permit issued by the DSHW on November 30, 1990.

According to Mr. Nelson, the site has three trusts. The Utah DSHW has a trust to cover costs associated with mixed waste that is disposed in two cells, and the NRC is responsible for one trust covering radioactive mill tailings that are disposed in a separate cell. The LLRW Trust Fund covers LLRW that is disposed in two separate cells.

The balance of the LLRW Trust Fund is approximately $20.3 million in the form of a "letter of credit" held by Wells Fargo Inc., and funded by Envirocare's assets. The LLRW Trust Fund, which is funded by a surcharge fee on waste disposed at the LLRW disposal facility, covers closure and monitoring for 100 years.

A.8 Washington

The US Ecology LLRW disposal facility is located in Richland, Benton County, Washington, near the center of the Hanford Reservation, in the southeastern Washington desert. The 100-acre facility is bounded on all sides by federal land controlled by the DOE. The State of Washington is the prime leaseholder for the 100-acre tract and US Ecology subleases the area from the State of Washington. The facility began operation in 1965. Through 1995, it had received more than 13 million cubic feet of LLRW. Additional LLRW disposal is projected until closure in 2056. Three levels of monitoring, maintenance, and control will be conducted following the operational period. A 2-year closure period will be implemented followed by a 5-year stabilization period. The third level is the 100-year institutional control period. Separate funds exist for facility closure and for the institutional control phases for the facility. As of December 1995, the Site Closure Account balance was $22,818,197. No additional monies are added to this account except for interest. The balance of the Perpetual Care/Maintenance (PC&M) Account as of December 1995 was $22,993,995. A $1.75 per cubic foot fee is collected by US Ecology for the PC&M account. The State of Washington controls both accounts. Based on the projected waste disposal rate, and assuming a 2 percent real growth rate, the balance of the PC&M account at the end of the operational period will be a reported $97.5 million.

APPENDIX B

JANUARY 31, 1992 REQUEST FOR DISBURSEMENT

APPENDIX C

BIBLIOGRAPHY

BIBLIOGRAPHY

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